Report of the Fraser River Panel to the Pacific Salmon Commission on the 2001 Fraser River Sockeye and Pink Salmon Fishing Season

Prepared by the

Pacific Salmon Commission

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REPORT OF THE

FRASER RIVER PANEL

TO THE PACIFIC SALMON COMMISSION

ON THE 2001 FRASER RIVER SOCKEYE AND PINK

SALMON FISHING SEASON

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I. EXECUTIVE SUMMARY

1. In 2001, the Fraser River Panel managed fisheries in the Panel Area that targeted Fraser River sockeye and pink salmon, under the terms of Annex IV of the Pacific Salmon Treaty that was revised on June 30, 1999. Chapter 4 of the Agreement provides catch sharing arrangements for Fraser River sockeye and pink salmon for the period 1999-2010. Under the terms of the Agreement, the 2001 United States sockeye catch in Panel Areas (Washington) was not to exceed 18.4% of the Total Allowable Catch (TAC) of Fraser River sockeye salmon minus a payback of up to 56,000 fish due to a catch overage in 2000. For Fraser River pink salmon, the United States share of the TAC was 25.7% plus up to 21,000 fish due to a catch underage in 1999. Panel Area fisheries in Canada were to be managed by the Fraser River Panel and Canadian fisheries outside the Panel Area were to be managed by Canada in a manner that considered catches in United States fisheries.

2. Canada provided the Panel with run-size forecasts for Fraser River sockeye and pink salmon and guidelines for calculating spawning escapement targets at a meeting held on April 18-19, 2001. The forecasts were at five probability levels: 25%, 50%, 75%, 80% and 90% probabilities that the run size would be exceeded. Canada identified conservation concerns for Early Stuart, Early Summer-run and Late-run sockeye run timing groups. Summer-run sockeye were expected to provide the largest share of the catch. Late-run sockeye conservation concerns assumed that recent-year early river entry timing and associated high mortality that has occurred over the last several years would occur again in 2001.

3. The Panel used the Fishery Simulation Model to examine potential management options for Fraser River sockeye salmon at the 50%, and 75% probability level forecasts, which were 12,865,000, and 6,798,000 fish, respectively. The Fraser River pink salmon run size at the 50% probability level forecast was 5,468,000 fish. The corresponding spawning escapement targets for sockeye were 4,640,000, and 3,605,000 fish, respectively and 4,648,000 fish for pink salmon. The projected TAC at these run sizes for sockeye were 6,908,000, and 2,720,000 fish, respectively, and 615,000 and 333,000 pink salmon.

4. Domestic allocation targets for Fraser sockeye in Washington were as follows: Treaty Indian fishers were allocated 61% of the United States TAC minus 35,000 fish of the 56,000 fish payback, while Non-Indian fishers were allocated the remaining 39% of the TAC less 22,000 of the 56,000 fish payback. Among Treaty Indians, fishers in Areas 4B, 5 and 6C were allocated a maximum of 12% of the Treaty Indian share. The allocation among Non-Indian fishers was 54% for purse seines, 41% for gillnets and 5% for reefnets. Domestic allocation targets for Fraser River pink salmon in Washington were as follows: Treaty Indian and Non-Indian fishers were each allocated 50% of the United States TAC plus 11,000 pink salmon as payback for the 1999 catch shortfall.

5. Domestic allocation targets for Fraser sockeye in Canadian commercial fisheries were as follows: 44% for Area B purse seines, 14.5% for Area D gillnets, 20.5% for Area E gillnets, 11% for Area G trollers and 10% for Area H trollers. Domestic commercial allocation targets for Fraser River pink salmon were 60% for Area B purse seines, 4% for Area D gillnets, 1% for Area E gillnets, 22% for Area G trollers, and 13% for Area H trollers.

6. The forecasts of diversion rate through Johnstone Strait were 25% and 64% for Fraser River sockeye and pink salmon, respectively. The forecasts of run timing (50% cumulative migration through Canadian Area 20 – Juan de Fuca Strait) were June 30 for Early Stuart sockeye, August 1 for Chilko sockeye, and September 2 for Fraser River pink salmon.

7. Simulation modeling of harvest strategies for Summer-run sockeye indicated that a significant proportion of the TAC of Summer-run stocks could not be harvested at the 50% probability level forecast due to constraints imposed by the conservation needs of Early Summer-run and Late-run stocks. Differences between the Parties in the preferred approach to in-season management led the Panel to request that the Commission assist in resolving the impasse. On

June 28, 2001, the Commission reached agreement on a set of principles that limited the exploitation rate on Late-run stocks to 17% of the run and set a maximum 60% harvest rate for Summer-run sockeye.

8. Based on the Commission agreement, the Panel developed a fishing regime and management plan for Panel Area fisheries on July 3 and recommended that the Commission approve the regime and plan. The Commission accepted the regime and plan and recommended these to the Governments.

9. The Panel's management plan focussed on the conservation of Early Summer-run and Late-run sockeye stocks and on the harvest of Summer-run sockeye. Fishery restrictions were anticipated early in the season to protect Early Stuart and Early Summer-run sockeye and late in the season to protect Late-run stocks. A two week "window of opportunity" was identified in simulation modelling for fisheries to harvest Summer-run stocks without compromising escapement of Early Stuart, Early Summer-run and Late-run stocks.

10. Between June 28 and September 18, the Panel met 27 times (by telephone conference and in-person) to discuss run status and enact in-season orders to regulate fisheries. PSC staff provided periodic updates on catches, escapements and racial composition and recommended adoption of in-season run-size estimates. The Panel adopted regulations for Panel Area fisheries consistent with the pre-season planning constraints.

11. Panel Area fisheries for sockeye salmon were confined to July 25 to August 8, except for a United States reefnet fishery on August 18. Fisheries directed at Fraser River pink salmon were conducted between September 4-19 with non-retention of sockeye and other species. Lower than expected returns of sockeye salmon and larger numbers of pink salmon led to fisheries that differed from pre-season plans.

12. Catches of Fraser River sockeye salmon in all fisheries totalled 1,604,000 fish. The Canadian catch was 1,197,000 sockeye, United States fishers harvested 284,000 fish, and test fishery catches totalled 123,000 sockeye. Canadian catches included 297,000 fish in commercial fisheries, 848,000 fish in First Nations' fisheries, 37,000 fish in recreational fisheries, 12,000 fish in charter fisheries and 3,000 Weaver Creek sockeye in an "excess salmon to spawning requirements" (ESSR) fishery (male sockeye only). Within the United States catch, 241,000 fish were harvested in Washington waters, including a ceremonial and subsistence catch of 11,000 fish. Commercial fishery catches in both countries summed to 570,000 fish.

13. Catches of Fraser River pink salmon totalled 1,450,000 fish: 967,000 fish in Canada, 445,000 fish in United States and 38,000 fish in Panel-approved test fisheries. Included in the Canadian total were 757,000 fish in commercial, 134,000 fish in First Nations', 74,000 fish in recreational and 2,000 fish in charter fisheries. In the United States fishery 426,000 pink salmon were harvested in commercial, 18,000 fish in recreational and 1,000 fish in ceremonial and subsistence fisheries.

14. The Stock Monitoring program provided in-season estimates of abundance, migration timing and diversion rate of Fraser River sockeye and pink salmon throughout the fishing season. The peak migration timing through to Area 20 was June 28 for Early Stuart sockeye (five days earlier than average), July 17 for Early Summer-run sockeye (four days earlier than average), August 7 for Summer-run sockeye (approximately four days later than average), August 12 for Late-run sockeye (approximately six days earlier than average), and September 2 for Fraser River pink salmon (five days later than average). The overall diversion rate of Fraser sockeye through Johnstone Strait was estimated to be 20% while approximately 60% of Fraser pink salmon migrated via Johnstone Strait.

15. The Racial Identification program provided estimates of stock composition for sockeye catches in commercial, Aboriginal and test fisheries. Scale, parasite and microsatellite DNA data were employed in this process. Stock composition data were used to estimate the run size and gross escapement of individual stock groups. The primary difficulties were in discriminating the: (1) Chilko/Quesnel from the Fennell/Bowron/Chilliwack stock groups; and (2) Late Stuart/Stellako,

Nadina/Pitt, Birkenhead/Adams/Cultus and Weaver/Portage stock groups using scale analysis. A post-season re-analysis using standards developed from spawning ground scales led to minor revisions to racial composition estimates. DNA estimates of stock composition confirmed the presence of Late-run sockeye at critical times during the season. Genetic stock identification (GSI) techniques were used to estimate the contribution of Fraser River pink salmon in commercial and test fisheries.

16. The adult return of Early Stuart sockeye (214,000 fish) was near the 75% probability level forecast; Early Summer-run abundance (393,000 fish) was almost double the 50% probability level forecast; Summer-run sockeye (6,043,000 fish) were near the 75% probability level forecast and Late-run sockeye (541,000 fish) returned at slightly higher than the 50% probability level forecast of abundance. Overall, the return (7,191,000 adults and 21,000 jacks) was slightly higher than half of the 50% probability level forecast. Among the Summer-run stocks, Quesnel sockeye dominated the returns, followed by Chilko, Late Stuart, and Stellako sockeye. The largest Late-run return was from Weaver sockeye, followed by Adams, Harrison, Birkenhead, and Portage sockeye. The return of Fraser River pink salmon (21,193,000 fish) was almost four times the 50% probability level forecast.

17. The pre-season exploitation rate limit on "true" Late-run sockeye (Adams, Lower Shuswap, Portage, Weaver, Harrison, Cultus, but not Birkenhead sockeye) of 17% was slightly exceeded (19%).

18. Recruitment of age 4 sockeye was low in 2001 to all of the stock groups. Recruitment of Late Stuart and many other of the upper Fraser stocks was low, and recruitment of Early Stuart (0.40 adult age 4 fish per brood year spawner) was particularly low. Chilko smolt survival to age 4 was 3.0% compared to a long-term average of 9.4%.

19. Near-final estimates of spawning escapements to streams in the Fraser River watershed totalled 5,256,000 adult sockeye. This escapement was 24% larger than the brood year (1997) escapement of 4,252,000 adults. Spawning escapements for Early Stuart sockeye (171,000 fish) were 36% lower than the brood year; Early Summer-run escapements (302,000 fish) were a record for the cycle and over three times the brood year escapement; Summer-run escapements (4,683,000 fish) were 23% higher than the brood year; and Late-run escapement (100,000 fish) was 11% higher than the brood year (although Late-run sockeye experienced high en route mortality). Pink salmon escapements of 19,843,000 fish were over 53% higher than the previous record escapement. The success of spawning by female sockeye in the entire watershed averaged 92%, which exceeded the brood year spawning success rate (89%).

20. Adjusted gross escapement targets (target + management adjustment) for sockeye salmon were nearly achieved or exceeded for each run-timing group based on lower river estimates (in-season Mission escapement plus First Nations' catch below Mission). Gross escapement targets were short by 4,000 fish for Early Stuart sockeye and exceeded by 141,000 fish for Early Summer-run stocks, by 412,000 fish for Summer-run stocks and by 26,000 fish for Late-run stocks. The total in-season gross escapement estimate exceeded the adjusted target by 575,000 sockeye.

21. Upriver estimates of gross escapement (in-river catch plus spawning escapement) totalled 1,282,000 sockeye more than the unadjusted target. By run-timing group, gross escapements were 45,000 fish over for Early Stuart, 251,000 fish over for Early Summer-run, 1,322,000 fish over for Summer-run and 336,000 fish short for Late-run sockeye. The large shortfalls in Late-run escapements were due to high en route mortality.

22. In terms of the achievement of international allocation targets, the June 28, 2001, Commission agreement stated that the United States share would not be adjusted post-season as a consequence of Canadian domestic policies that result in Canada not achieving its share. Under this provision, the Commission agreed on June 11-12, 2002 that the United States catch of sockeye in 2001 would be treated as the actual share. With respect to pink salmon, the Parties agreed that for the 2001 season, the international allocation of pink salmon would equal the catch taken by each respective country, with no penalties arising from post-season accounting adjustments.

23. In relation to domestic allocation goals, in the United States Treaty Indian fishers caught 25,000 more fish than their allocation and Non-Indian fishers harvested 25,000 fish less than their allocation. Among Treaty Indians, the catch in Areas 4B, 5 and 6C was 16,000 fish over their maximum share of 12% while fisheries in Areas 6, 7 and 7A were 16,000 fish short. Among Non-Indian fishers, purse seine and reefnets exceeded their allocations by 2,000 and 6,000 fish, respectively, while gillnets were 8,000 fish short. With regard to pink salmon, Treaty Indian fishers were 104,000 fish short and Non-Indians 104,000 fish over their allocations.

24. Domestic allocation goals in Canada were not achieved, largely because of the substantial restrictions of fisheries due to the lower abundance of Summer-run sockeye and conservation concerns for Early Summer-run and Late-run fish. Within the Canadian commercial catch of 297,000 Fraser sockeye, Area B purse seines were 52,000 fish under, Area D gillnets were 51,000 fish over, Area E gillnets were 17,000 fish under, Area G trollers were 13,000 fish under and Area H trollers were 31,000 fish over their allocations. With respect to Fraser River pink salmon, Area B purse seines were 217,000 fish over, Area D gillnets were 23,000 fish under, Area E gillnets were 8,000 fish under, Area G trollers were 151,000 fish under and Area H trollers were 35,000 fish under their respective allocations.

25. The restrained fisheries in 2001 resulted in low by-catches of other species and stocks that were identified as conservation concerns by the Parties.

26. In terms of the allocation status for the purpose of calculating catch paybacks in future years, the United States has an overage of 56,000 sockeye and an underage of 21,000 pink salmon.

II. FRASER RIVER PANEL

Under the Pacific Salmon Treaty, the Fraser River Panel is responsible for in-season management of fisheries that target Fraser River sockeye and pink salmon within the Panel Area (Figure 1). Prior to the fishing season, the Panel recommends a fishery regime and a management plan for Panel Area fisheries to the Pacific Salmon Commission (PSC). The plan is based on: (1) abundance and timing forecasts and escapement targets for Fraser River sockeye and pink salmon stocks provided by Fisheries and Oceans Canada (DFO); (2) international catch allocation goals set by the agreements between the Parties; (3) domestic catch allocation goals of each country; (4) management concerns for other stocks and species also identified by each country; and (5) historic patterns in migration and fisheries dynamics. The objectives that guide the Panel's decision-making listed in descending priority are: to achieve the spawning escapement targets, meet international catch allocation goals, and meet domestic catch allocation objectives. Conservation concerns of the Parties for other species and stocks are addressed throughout the process.

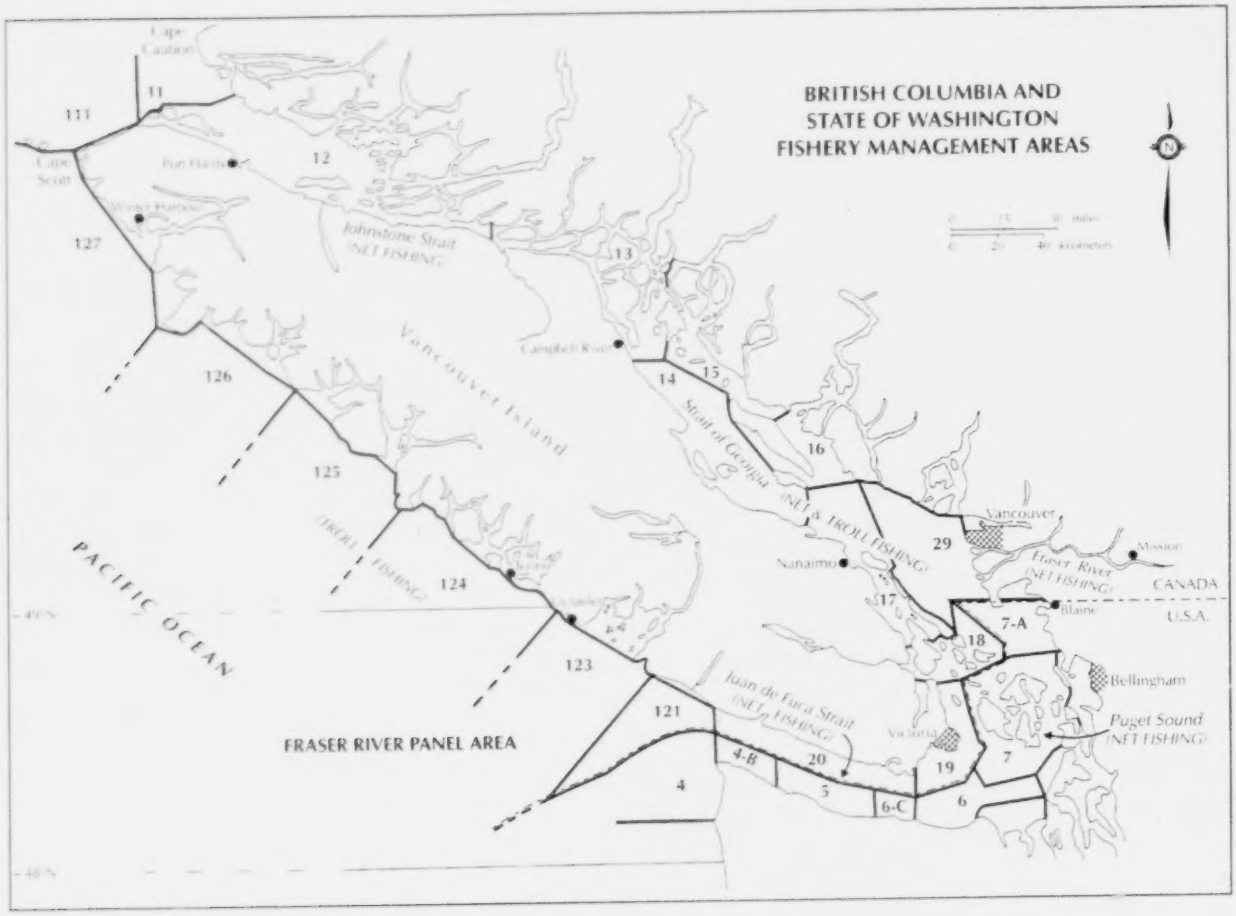

Figure 1. Fishery management areas and commercial gear used in the Fraser River Panel Area and Canadian south coast waters.

In 2001, the pre-season management plan adopted by the Panel was based on fishery scenarios that were designed to achieve the escapement targets and catch goals, given two levels of pre-season expectations. These were the 50% and 75% probability level forecasts of abundance.

The two scenarios provided the Panel with approximate dates of first openings in each Panel Area fishery. Using in-season commercial and test fishing data and analyses from PSC staff, the Panel developed a weekly fishing pattern in response to in-season deviations from expectations. The activities of the Panel were facilitated by the Fraser River Panel Technical Committee, who worked in conjunction with the PSC staff and provided their respective National sections of the Panel with technical advice.

Under the terms of the revised Chapter 4 of Annex IV of the Pacific Salmon Treaty (1999) between Canada and the United States, the Panel exercised its regulatory mandate in Panel Areas only for commercial net fisheries and the Canadian inside (Strait of Georgia) troll fishery directed at Fraser River sockeye and pink salmon. The development of management plans for other species and stocks intercepted in south coast areas are the responsibility of the Southern Panel and the Commission, and the actual management in specific areas is the responsibility of the appropriate country.

Involvement in decision-making occurs primarily through the National Sections of the Panel, which is where most of the user groups are represented. The Panel membership and their affiliations during the 2001 season were:

CANADA	UNITED STATES
Members	
Mr. W. Saito, Chair Fisheries and Oceans Canada	Mr. D. Cantillon, Vice-Chair National Marine Fisheries Service
Mr. M. Chatwin Salmon processing industry	Mr. R. Lincoln Washington Department of Fish and Wildlife
Mr. M. Griswold Troll fisher	Ms. L. Loomis, Chair Treaty Indian tribes
Mr. T. Lubzinski Gillnet fisher	Mr. B. Suggs Commercial salmon fishing industry
Chief S. McKamey Canadian First Nations	
Mr. L. Wick Purse seine fisher	
Alternates	
Mr. B. Assu Purse seine fisher	Mr. R. Charles Treaty Indian tribes
Mr. W. Otway Sport fisher	Mr. P. Patillo Washington Department of Fish and Wildlife
Mr. L. Rombough Gillnet fisher	Mr. W. Robinson National Marine Fisheries Service
Mr. P. Ryall Fisheries and Oceans Canada	Mr. R. Zuanich Commercial salmon fishing industry
Mr. S. Watterson Troll fisher	

III. INTRODUCTION

While many issues were of high concern to the Fraser River Panel in 2001, the continuing early upstream migration of Late-run sockeye and subsequent high mortality rate was the most troubling. In addition to providing an update on the Late-run sockeye crisis, a summary of the 2001 season is provided below, including: the pre-season planning process, which included identification of conservation concerns; a discussion of in-season management issues; a comparison of the forecast and actual returns of Fraser River sockeye and pink salmon; and a comparison of Mission-based and spawning grounds estimates of Summer-run sockeye gross escapements.

Summary of the 2001 Season

During pre-season planning for fisheries on Fraser River sockeye and pink salmon in spring 2001, Fisheries and Oceans Canada identified conservation concerns for Early Stuart, Early Summer-run and Late-run sockeye run-timing groups. The run sizes of Early Stuart and Early Summer-run sockeye were forecast to be weak, while there was concern for the continued early upstream migration and high en route mortality of Late-run stocks, which were deemed to require special protection from excessive harvest. Conversely, Summer-run stocks, particularly those returning to the Quesnel Lake watershed, were forecast to be abundant. The Panel examined options for harvesting Summer-run stocks without adversely impacting the co-migrating sockeye from the other run-timing groups. A short "window of opportunity" for fishing was identified by the Fraser River Panel Technical Committee and PSC staff using the Fishery Simulation Model. However, during simulation modeling, it became evident that a considerable proportion of the TAC of Summer-run sockeye could not be harvested if the runs returned near the 50% probability level forecasts of abundance, without exceeding target harvest rates on overlapping Early Summer-run and Late-run stocks. Differences between the national sections of the Panel on how to plan the fisheries led the Panel to request review of this issue by the Commission. The Commission reached an agreement on June 28, 2001 (Appendix B) that directed the Panel to plan fisheries that minimized the catch of Late-run sockeye (not to exceed a 17% exploitation rate) while allowing a reasonably high harvest rate on Summer-run stocks (maximum 60% harvest rate).

The conservation concerns for Early Stuart and Early Summer-run sockeye that were identified during pre-season planning came as a result of high en route and pre-spawning (occurring on the spawning grounds) mortality of adult sockeye in 1997 and apparent low egg-to-fry survival from this brood. The peak of the Early Stuart run and the early portion of the Early Summer-run migration encountered extremely high discharge and turbidity levels in the Fraser Canyon during mid-to-late July, 1997. En route losses of these two run-timing groups were estimated at 680,000 fish and 48,000 fish, or 72% and 48% of the gross escapements, respectively. Many of the adult fish that survived these adverse conditions were severely stressed and delayed in their migration, which resulted in low egg-to-fry survival (confirmed by observations on Early Stuart and Nadina River sockeye) from fish that survived to spawn. Consequently, the 2001 run-size forecasts were low for age 4 Early Stuart sockeye and Early Summer-run sockeye stocks that spawn upstream of the Fraser Canyon. Commercial fisheries were not conducted during the marine migration of Early Stuart sockeye. In addition, at Canada's request, the Panel closed all Panel Area commercial fishing during the peak upstream migration period of Early Summer-run stocks to mitigate anticipated low returns of these stocks.

Conservation concerns for "true" Late-run sockeye stocks (Adams, Lower Shuswap, Portage, Weaver, Harrison, Cultus, but not Birkenhead sockeye) that normally delay in the Strait of Georgia for three to six weeks were based on high en route and pre-spawning mortality associated with their early migration into the Fraser River in recent years and the expectation that this behaviour would continue in 2001. In 2000, Weaver Creek Late-run sockeye migrated into the Fraser River approximately 47 days earlier (50% date – August 13) than the historic average date (September 29). Based on the difference between Mission and upstream estimates of escapement it appeared that over 90% of Late-run sockeye that migrated upstream early died prior to spawning.

The Commission agreement to limit the exploitation rate to a maximum of 17% on Late-run stocks was intended to increase the probability of achieving an adequate escapement level if high en route mortality occurred again in 2001.

The abundance of Fraser River pink salmon was forecast to be low (5,468,000 fish at the 50% probability level and 4,049,000 at the 75% probability level) in 2001. At this low run size most of the return was required to meet the escapement goal and, therefore, only small, incidental catches of pink salmon in fisheries directed at Summer-run sockeye salmon were expected. Management plans for the conservation of Late-run sockeye (the latter part of which co-migrate with Fraser pinks) were expected to minimize the harvest rate on pink salmon.

During the season, fishing opportunities on Summer-run sockeye were constrained to approximately a two-week window because of the conservation concerns for Early Summer-run and Late-run stocks (Figure 2). The in-season estimates of Summer-run sockeye abundance were much lower than anticipated, which reduced the harvestable surplus. However, high uncertainty in the estimation of Summer-run abundance necessitated a cautious approach to recommending fisheries. When Summer-run sockeye were anticipated to peak in the Fraser River, the number of fish entering the river indicated that the run size was lower than earlier estimated. Based on these observations, PSC staff recommended a reduction in run size from 6,000,000 fish to 4,000,000 fish. As a result of this decrease in the estimate of Summer-run sockeye at this critical point in the season (August 8), the Panel delayed recommendations for further fishing. Later, when indicators suggested that the abundance of Summer-run sockeye was larger than 4,000,000 fish; Late-run conservation requirements prevented further fishing in Panel area waters. Migration of Summer-run sockeye after mid-August resulted in the in-season estimate of gross escapement exceeding the target by 254,000 fish.

Figure 2. Commercial fishing period relative to the daily Summer-run sockeye abundance profile and to fishery closure periods for Early Summer-run and Late-run stocks in 2001.

A primary aspect of the difficulties that the Panel encountered in 2001 was that of the relative timing between Summer-run and Late-run stocks. Simulation modeling work was conducted with the assumption of average timing through Canadian Area 20, i.e., August 5 for Summer-run sockeye and August 15 for Late-run stocks. The ten-day difference used in the model indicated that at the 75% probability level forecast of abundance, the Summer-run TAC would be harvested. However, run timing observed in-season differed substantially from the assumed, normal timing. The 50% migration date of Summer-run stocks through Juan de Fuca Strait was later than normal

(August 7) while Late-run sockeye were earlier (August 12) than average. The five-day difference in run timing between Summer-run and Late-run sockeye, rather than the ten days that was expected, resulted in larger by-catches of Late-run sockeye during fisheries targeting Summer-run sockeye. Not all of the available TAC of Summer-run sockeye could be harvested before the Late-run maximum exploitation rate of 17% was reached.

Prior to the season, the Panel anticipated that the timing overlap of Fraser River pink salmon and Late-run sockeye would be beneficial for pink salmon conservation. However, during the season, conservation of Late-run sockeye and other species impacted the Panel's ability to formulate regulations to harvest the unexpectedly large return of Fraser River pink salmon. Accurate in-season estimation of Fraser River pink salmon run size was difficult because of the lack of assessment data from commercial fisheries near the peak of the pink salmon migration. Purse seine test fishing data were used instead, which generally results in run-size estimates that are less accurate and precise than those based on commercial fishing data. Consequently, PSC staff were cautious in their interpretation of the test fishing data and adopted a conservative approach to the estimation of run size. The last in-season estimate of Fraser River pink salmon run-size (10,000,000 fish) was less than half of the post-season estimate but provided some harvest opportunities.

In-season estimates of most sockeye returns varied substantially from the pre-season 50% probability level forecasts. Early Stuart and Summer-run returns were near the 75% probability level forecasts while Early Summer-run sockeye returns were larger than the 50% probability level forecast and Late-run returns were at the 50% probability level forecast. In general, age 4 sockeye returns were less than half of the 50% probability level forecasts. This occurred in all of the run-timing groups. In 1997, the dominant cycle return of Early Stuart sockeye was 1,652,000 age 4 fish, but the high en route mortality of the escapement and low egg-to-fry and marine survival of their offspring led to a return of only 109,000 age 4 fish in 2001. Similarly, the age 4 return of Early Summer-run sockeye in 1997 was estimated at 238,000 fish, but in 2001 only 75,000 age 4 fish returned. Fortunately, age 5 sockeye returns of Early Summer-run stocks were considerably higher than the forecast abundance. Age 5 fish contributed approximately 81% of the production and spawning escapement of the Early Summer-run stocks in 2001, compared to a 1981-1997 cycle average of 31%.

The return of age 4 Summer-run sockeye declined from 13,426,000 fish in 1997 to 5,441,000 sockeye in 2001. While poor freshwater survival was likely responsible for part of the low returns of age 4 fish in the early-timed stocks, the lower-than-forecast abundance of Summer-run sockeye in 2001 cannot be attributed to known freshwater survival problems. DFO estimates of juvenile abundance in Quesnel and Chilko Lakes were near or above average for the cycle line. However, survival from juvenile to adult was low (Chilko sockeye smolt-to-adult survival was 3.0% compared to a long-term average of 9.4%). The Late Stuart sockeye rate of return was similar to the Early Stuart return (i.e., approximately 0.4 adult age 4 fish per brood year adult spawner). The low return-rates from several upper Fraser sockeye stocks suggests that survival rates were low.

The abundance of adult Late-run sockeye observed in 2001 (541,000 fish) was slightly higher than the 50% probability level. This consistency between the forecasted and actual run sizes of Late-run sockeye were coincidental since the 50% probability level forecast was for a production of 420,000 age 4 fish while only 235,000 age 4 fish returned. The discrepancy in returning age 4 fish was compensated for by higher returns of age 3 and age 5 adult sockeye. Recruitment rates for Late-run sockeye were below average, but not as low as in earlier-timed run-timing groups.

The return of 21,293,000 Fraser River pink salmon in 2001 was approximately four times larger than the 50% probability level forecast. The pink salmon run in 2001 was the first year since 1991 that the return-year run size was larger than the brood year return. During the period from 1991 to 1999, the estimated total run of Fraser River pink salmon declined steadily by about 4,000,000 fish every odd-year from 22,173,000 fish in 1991 to 3,616,000 fish in 1999. The fry-to-adult survival rate of Fraser River pink in the 2001 return year was estimated at 9.6%, which was approximately three times higher than the long-term average survival and 55% higher than the previous record high estimate. The pre-season forecast provided by Canada was based on total fry production from the 1999 brood and marine environmental conditions. Recent oceanographic

changes in the Strait of Georgia and along the west coast of Vancouver Island have resulted in increased zooplankton levels. The high survival of the 1999 brood juveniles during the summer of 2000 may be associated with these environmental changes.

While the spawning escapement estimate for Early Stuart sockeye (171,000 fish) was near the projection based on in-season gross escapement data, the escapement of Early Summer-run sockeye was approximately 100,000 fish higher than expected. This discrepancy arose from a large escapement to the Pitt River, which enters the Fraser below the hydroacoustic site at Mission. The spawning ground abundance of Summer-run sockeye was also larger than estimated in-season. In total, 4,683,000 Quesnel, Chilko, Late Stuart and Stellako sockeye arrived on their spawning grounds, which was nearly 1,000,000 fish more than projected in-season and 1,559,000 sockeye higher than the in-season spawning escapement target. The return to the Quesnel watershed was much larger than anticipated, while escapements to the other Summer-run sockeye spawning grounds were closer to the in-season estimates.

True Late-run sockeye stocks were subject to large en route and pre-spawning losses again in 2001. From the estimated upstream migration of 471,000 Late-run sockeye, only 100,000 adult sockeye arrived at their spawning grounds. Birkenhead River and Big Silver Creek sockeye overlap in migration through marine areas but typically delay in the Strait of Georgia for only one to two weeks. These two stocks contributed 56,000 fish of those that arrived successfully and appeared to suffer little mortality. A total of 44,000 adult fish from the true Late-run stocks arrived on the spawning grounds from an upstream migration estimated at 375,000 fish. Pre-spawning mortality of female sockeye that appeared on the spawning grounds (20.0%) was over four times the cycle average and further reduced the number of true Late-run sockeye that spawned successfully to less than 10% of the potential number.

Fraser River pink salmon escaped in record numbers to their spawning grounds in 2001. An estimated 19,843,000 fish migrated upstream. The final in-season pink salmon assessment had suggested that the escapement would exceed 10,000,000 fish, but did not indicate the magnitude of escapement estimated in-river.

An analysis of the in-season estimates of sockeye salmon escapement past Mission was conducted to determine if errors or biases occurred in these assessments. A reconstruction of sockeye arrivals at Summer-run sockeye spawning areas and catches upstream of Mission were compared to hydroacoustic estimates of abundance at Mission (Figure 3). The difference of over 1,000,000 fish between estimates appears to have occurred after mid-August. While the fishery closures for conservation of Late-run sockeye were in place at the time, these did not appear to have influenced the estimation process. Estimates of the species composition of salmon passing Mission during the early part of the pink salmon migration were also rejected in the under-estimate of sockeye, as was the possibility that in-season stock identification errors had caused an under-estimation of Summer-run sockeye abundance. The potential of low bias in hydroacoustic estimates of daily salmon passage at Mission were assessed with split-beam hydroacoustic data. However, the analysis did not indicate where, if at all, hydroacoustic estimates were low. The discrepancy between Mission and upstream estimates was primarily in Quesnel sockeye, which comprised a large portion of the Summer-run escapement after mid-August. A post-season analysis of these data did not indicate an obvious cause for the difference between these estimates.

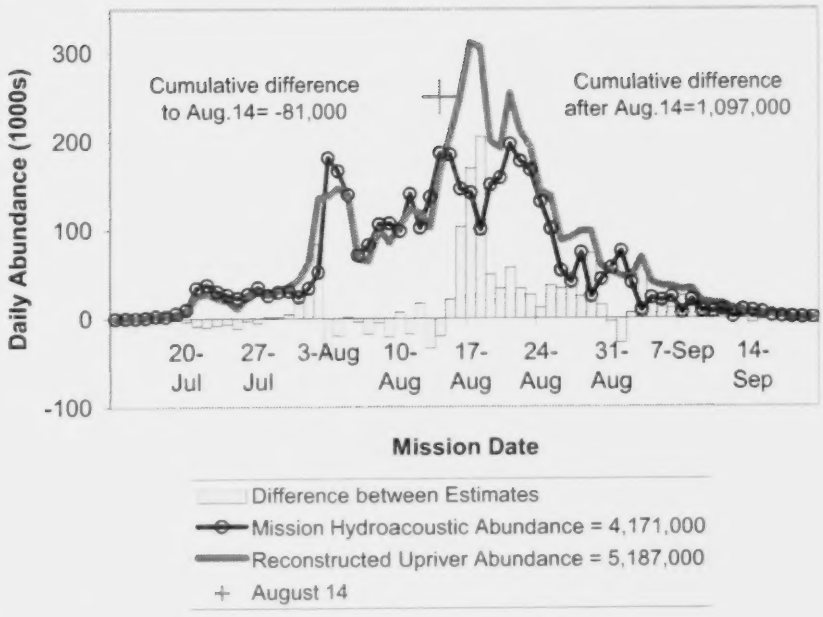

Figure 3. Comparison of Summer-run sockeye daily escapement estimates at (a) Mission and (b) reconstructed from arrival data near to and on the spawning grounds, plus catch estimates.

Early Migration of Late-run Sockeye

As noted earlier, true Late-run sockeye historically have delayed in the Strait of Georgia for three to six weeks prior to entering the Fraser River between mid-September and early October. In 2001, for the sixth consecutive year, early migration of Late-run sockeye into the Fraser River was observed. Fraser River pink salmon typically delay in the Strait of Georgia for one to two weeks, however, in 2001 it was estimated that their delay was only one to two days.

The early upstream migration behaviour pattern of Late-run sockeye likely increases physiological stress on these fish and extends the freshwater residency period of Late-run sockeye. High en route and pre-spawning mortalities associated with a myxosporean parasite, *Parvicapsula minibicornis* have been recorded in recent years. While the main cause of these mortalities is believed to be this parasite, the early upstream migration of Late-run sockeye is believed to be the source of the "problem". This high mortality occurs because of the increased duration between infection by the parasite and maturation and spawning of the fish, resulting in the parasite developing to the point that the fish die before spawning.

The ocean migration timing and arrival of Late-run sockeye into the Strait of Georgia in 2001 was approximately ten days later than in 2000 and the upstream migration was similarly later. However, in both years the average period of residence in the Strait of Georgia was only about one day. The later migration timing and cooler water temperatures in 2001 may have decreased the stress on the fish. Freshwater mortality from the time Weaver Creek sockeye entered the Fraser River until spawning was estimated at approximately 86%, (which was consistent with the results of a Late-run sockeye tagging study at the Harrison River in 2001), compared to 96% in 2000. Although small numbers of Adams River sockeye returned in 2001, the calculated en route and pre-spawning mortality rate was similar to Weaver Creek sockeye. The very high mortality rate sustained by true Late-run sockeye stocks in 2001 increased the concern for the sustained biological viability of these stocks. If this early entry phenomenon is not rectified naturally or

through some corrective measures, future Fraser River sockeye and pink salmon fisheries will continue to be subject to severe management constraints.

Three workshops were held between February 2001 and January 2002 to discuss potential causes of the early migration of Late-run sockeye and to plan research programs. Scientists from several disciplines attended and formulated hypotheses to focus research efforts. The Pacific Salmon Commission and the United States Government provided funds for seven research projects in 2001 aimed at identifying the cause(s) of this early entry behaviour (Appendix C). In addition, Fisheries and Oceans Canada initiated programs in 2001 to assess the following: (1) the incidence and infection rates of the parasite, *Parvicapsula minibicornis*, in several Fraser River sockeye stocks; (2) the mortality of Weaver and Portage sockeye relative to their arrival timing; (3) the enhancement/rehabilitation of affected populations; and (4) the recovery strategies for Cultus Lake sockeye.

To date, no conclusive evidence has emerged that identifies a probable cause of the early upstream migration behaviour. The research studies in 2001 were pilot programs that have highlighted the difficulty we face in determining the cause of the behavioural pattern change. Thus far, it is unknown whether these fish are being attracted unusually early to the Fraser River or are avoiding something in the Strait of Georgia that disrupts their normal delay behaviour. Intensive, sustained research on this problem is required to determine the factors motivating this highly detrimental behaviour in the Late-run stocks.

IV. MANAGEMENT ACTIONS

A. Forecasts of Returns, Escapement Targets, and Potential TAC

Canada presented the Panel with Fraser River sockeye and pink salmon run-size forecasts, and a "near final" spawning escapement target plan for both species, at the Fraser Panel meeting held on April 18-19, 2001. The data used to develop the pre-season run-size forecasts provided highly uncertain estimates of the potential return strength of sockeye stocks, and this uncertainty was reflected in the range of run-sizes relating to the various probability levels of the forecast. The Panel was provided with a range of probability levels of the forecast; specifically the 25%, 50%, 75%, 80% and 90% probabilities of the run size exceeding a specified projection (Appendix A, Table 1). For planning purposes, the Panel used the 50% and 75% probability level forecasts for sockeye (12,865,000 fish and 6,798,000 fish, respectively), and pink salmon (5,468,000 fish and 4,049,000 fish, respectively).

Canada provided a method of calculating spawning escapement targets for sockeye by stock group, and all Fraser River pink salmon, as a function of returning run size (Appendix A, Table 2). Based on this calculation method, Canada established spawning escapement targets for the range of forecast run-sizes presented to the Panel. The sockeye spawning escapement targets relating to the forecast run-sizes at the 50% and 75% probability level forecasts noted above were 4,640,000 and 3,605,000 fish, respectively. The corresponding pink salmon escapement target (defined by applying a maximum harvest rate of 15%) at the 50% probability level forecasts was 4,648,000 fish.

Forecasts of peak (50% run passage through Canadian Area 20) arrival timing, with associated prediction intervals, for Early Stuart sockeye were provided on June 19, and for Chilko sockeye on July 11. Both stocks were forecast to have earlier than average peak arrival timing in Area 20 of June 30 (Early Stuart) and August 1 (Chilko). On July 11, DFO also provided a forecast of the sockeye salmon diversion rate through Johnstone Strait of 25%, which was based on mean April to June sea surface temperatures measured at Kains Island. Forecasts of peak arrival timing in Area 20 (September 2) and the Johnstone Strait diversion rate (64%) for Fraser River pink salmon were provided on August 22.

At a meeting on July 3, the Fraser River Panel approved the 2001 fishery management plans for Fraser River sockeye and pink salmon in Panel Area waters. Uncertainty about the forecast abundances for sockeye stocks led the Panel to develop fishery plans at return abundances corresponding with the 50% and 75% probability level forecasts. The TAC's for Fraser River sockeye were calculated using the spawning escapement targets, projected test fishery catches, proposed management adjustments, and an Aboriginal Fisheries Exemption of 400,000 fish as specified in Annex IV of the Pacific Salmon Treaty (Table 1). Pink salmon TAC's were calculated by deducting spawning escapement requirements and projected test fishing catches from the forecast abundance levels.

Management adjustments for the Early Stuart and Early Summer-run timing groups were included in the gross escapement targets. The management adjustments were employed to compensate for the historical trend toward lower upriver estimates of gross escapement compared to Mission hydroacoustic estimates for both run timing groups. Increased escapement targets are intended to compensate for expected upstream shortfalls in escapement.

PSC staff provided the Panel with daily abundance curves (Figure 4) that projected the arrival of Fraser River sockeye and pink salmon in Area 20. This figure shows the expected timing and abundance of major stocks in 2001, at the 50% probability level forecast (12,865,000 sockeye and 5,468,000 pink salmon).

Table 1. Pre-season forecasts of total runs, spawning escapement targets and other deductions, total allowable catches and Washington share of Fraser River sockeye and pink salmon in 2001. These expectations are shown for both the 50% and 75% probability levels for the run-size forecasts.

	Probability of Achieving Specified Run Size			
	Sockeye		**Pink**	
	50%	75%	50%	75%
Total Run Size	12,865,000	6,798,000	5,468,000	4,049,000
Deductions				
Spawning Escapement	5,373,000	3,608,000	4,833,000	3,701,000
Management Adjustment	84,000	0	n/a	n/a
Fraser AFS Exemption	400,000	400,000	0	0
Test Fishing	100,000	70,000	20,000	15,000
Total Deductions:	5,957,000	4,078,000	4,853,000	3,716,000
Total Allowable Catch:	6,908,000	2,720,000	615,000	333,000
Washington Share of TAC				
Calculated Share	1,271,000	500,000	158,000	86,000
U.S. Payback	(56,000)	(50,000)	21,000	21,000
Share + Payback:	1,215,000	450,000	179,000	107,000

* Washington share was not to exceed 18.4% of the of Fraser sockeye TAC and 25.7% of the Fraser pink TAC in 2001, according to revised (1999) Annex IV of the Pacific Salmon Treaty.

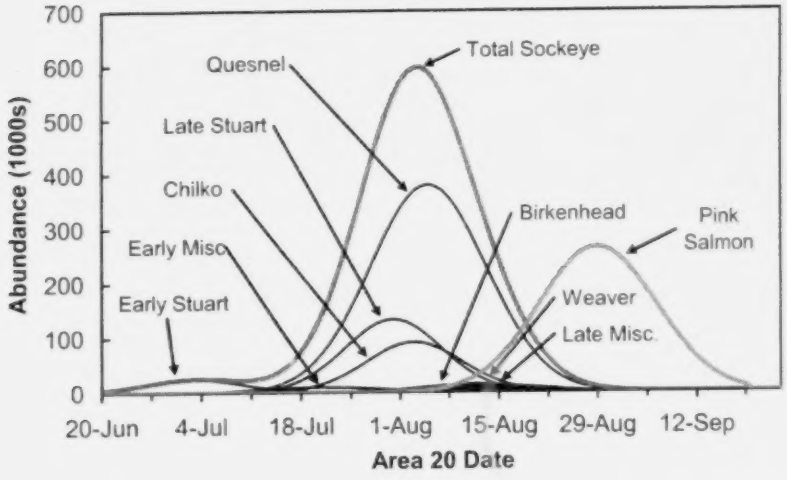

Figure 4. Expected daily abundance curves for migrating Fraser River sockeye and pink salmon in 2001 (Area 20 date), based on forecast abundances (50% probability level estimates) and timing patterns.

Based upon the pre-season forecasts, escapement targets, projected test fishing catches, and Aboriginal fishery exemptions, the TAC's available for international sharing at the 50% and 75% probability levels were: 6,908,000 and 2,720,000 sockeye and, 615,000 and 333,000 pink salmon, respectively (Table 1). The corresponding pre-season sockeye catch goals for Washington State fishers (18.4% of the TAC minus a 5% catch payback, up to 56,000 sockeye salmon, due to a catch overage in 2000) at the 50% and 75% probability level forecasts were 1,215,000 and 450,000 fish, respectively. The pink salmon catch goals for Washington State fishers (25.7% of the TAC plus a payback of up to 21,000 pink salmon due to a catch underage in 1999) at the 50% and 75% probability level forecasts were 179,000 and 108,000 fish, respectively.

Goals for the domestic allocation of Fraser sockeye among Washington fishers were as follows:

1. Treaty Indian fishers were to receive 61.0% of the United States TAC, minus the payback for the 2000 catch overage, while Non-Indian fishers would receive 39.0% of the TAC, minus the payback for the 2000 catch overage;
2. Treaty Indian fishers in Areas 4B, 5 and 6C were allocated a maximum of 12% of the Treaty Indian share; and
3. Among the Non-Indian commercial gear types, allocation goals were 54% for purse seines, 41% for gillnets and 5% for reefnets.

The domestic allocation goal for Fraser pink salmon among Washington fishers was for an equal share to Treaty and Non-Indian fishers. No inter-gear or area allocations were identified.

Canada did not identify a specific commercial TAC due to on-going negotiations with First Nations that sought to identify catch objectives to First Nations fishers in excess of the 400,000 sockeye Aboriginal fisheries exemption. However, DFO identified proportional sharing arrangements for the commercial sector as follows: (i) Fraser sockeye salmon: 44% for Area B purse seines, 14.5% for Area D gillnets, 20.5% for Area E gillnets, 11% for Area G trollers and 10% for Area H trollers; and (ii) Fraser pink salmon: 60% for Area B purse seines, 4% for Area D gillnets, 1% for Area E gillnets, 22% for Area G trollers and 13% for Area H trollers.

B. Pre-season Regulations

Discussions by the Panel and in "small group" meetings that commenced in April were designed to resolve differences between the Parties regarding the management approach for harvest of Summer-run sockeye in light of conservation concerns expressed by Canada on Early Summer-run sockeye and by both Parties on Late-run stocks. The Fishery Simulation Model was used to analyze options for fisheries management in 2001.

The Model was run with both the 50% and 75% probability level forecasts of abundance, gross escapement targets, and the international and domestic allocation goals outlined above. During the simulation modelling, DFO's forecasts of the diversion rate via Johnstone Strait (Figure 5), and 50% arrival timing dates for the Early Stuart (to the lower Fraser) and Chilko runs (to Area 20) were not available. However, it was anticipated that the diversion rate would not be high in 2001. Thus, a 35% diversion rate and average run timing was assumed for all stocks. The simulation modelling focussed on harvesting Summer-run (mainly Quesnel) sockeye. Restrictions on fishing were modelled early in the season to protect Early Stuart and Early Summer-run sockeye stocks and later in the season to protect Late-run sockeye stocks. The Commission provided harvest rate directives to the Fraser River Panel (Appendix B) that the harvest rates on Summer-run and Late-run sockeye were not to exceed 60% and 17%, respectively.

Results of the simulation modelling of the fishery at the 50% probability level forecast indicated that a sizeable fraction of the TAC of Summer-run sockeye could not be harvested if the constraints imposed by the conservation requirements for Early Summer-run and Late-run stocks were adhered to in the fishery. At the 75% probability level forecasts, the model indicated that the stocks could be harvested because with lower abundance levels, exploitation rates would be lower.

The Panel could not reach agreement on management strategies that allowed for the harvest of anticipated surpluses of Summer-run sockeye, while also minimizing the catch of Early Summer-run and Late-run sockeye. In an attempt to resolve the impasse, the Panel asked the Commission for guidance. The Commission provided the Panel with harvest rate directives for Late-run and Summer-run stocks (Appendix B) which formed the basis for a July 3 agreement on a 2001 Management Plan, including principals and constraints to be used in managing the 2001 fishery (Appendix D). Risk-averse management measures adopted by the Panel included a two-week moving fishery closure on Early Summer-run sockeye and the "Commission-agreed" maximum 17% exploitation rate on Late-run sockeye and 60% harvest rate on Summer-run sockeye. Along with the management plan, the Panel adopted regulations (Appendix E) for regulatory control of Panel Area waters. The Commission accepted the regulations and submitted them to the Parties. As per the revised (1999) Annex 4, Chapter IV of the Pacific Salmon Treaty, all sockeye and pink salmon fisheries regulated by the Panel were to be "closed unless opened" for fishing by in-season Orders of the Panel.

In the pre-season Management Plan, fisheries in United States Panel Area waters were anticipated to start during the week of July 22 – 28 in Areas 4B, 5 and 6C, and the week of July 29 – August 4 in Areas 6, 7 and 7A. These starting dates were expected to occur at both the 50% and 75% probability level forecasts of run size. However, at the 75% probability level forecasts the weekly fishing times would be reduced, and an earlier cessation of fishing would occur. Canadian Panel Area fisheries were expected to open during the week of July 29 – August 4 for Area B purse seiners, Area H trollers and Area E gillnetters at the 50% probability level forecast. At the 75% probability level forecast, Area E fisheries would be delayed, possibly commencing during the week of August 12-18, and other Canadian Panel Area fisheries would have reduced fishing times and earlier cessation dates.

During the pre-season planning process, the Parties identified a number of conservation and management concerns. Species and stocks identified as being of concern to Canada included Thompson River coho salmon, Lower and Upper Georgia Strait coho salmon, Johnstone Strait coho salmon, Thompson River steelhead and West Coast Vancouver Island and Harrison River chinook salmon. The species and stocks identified by the United States included Hood Canal summer-run chum and Puget Sound chinook salmon.

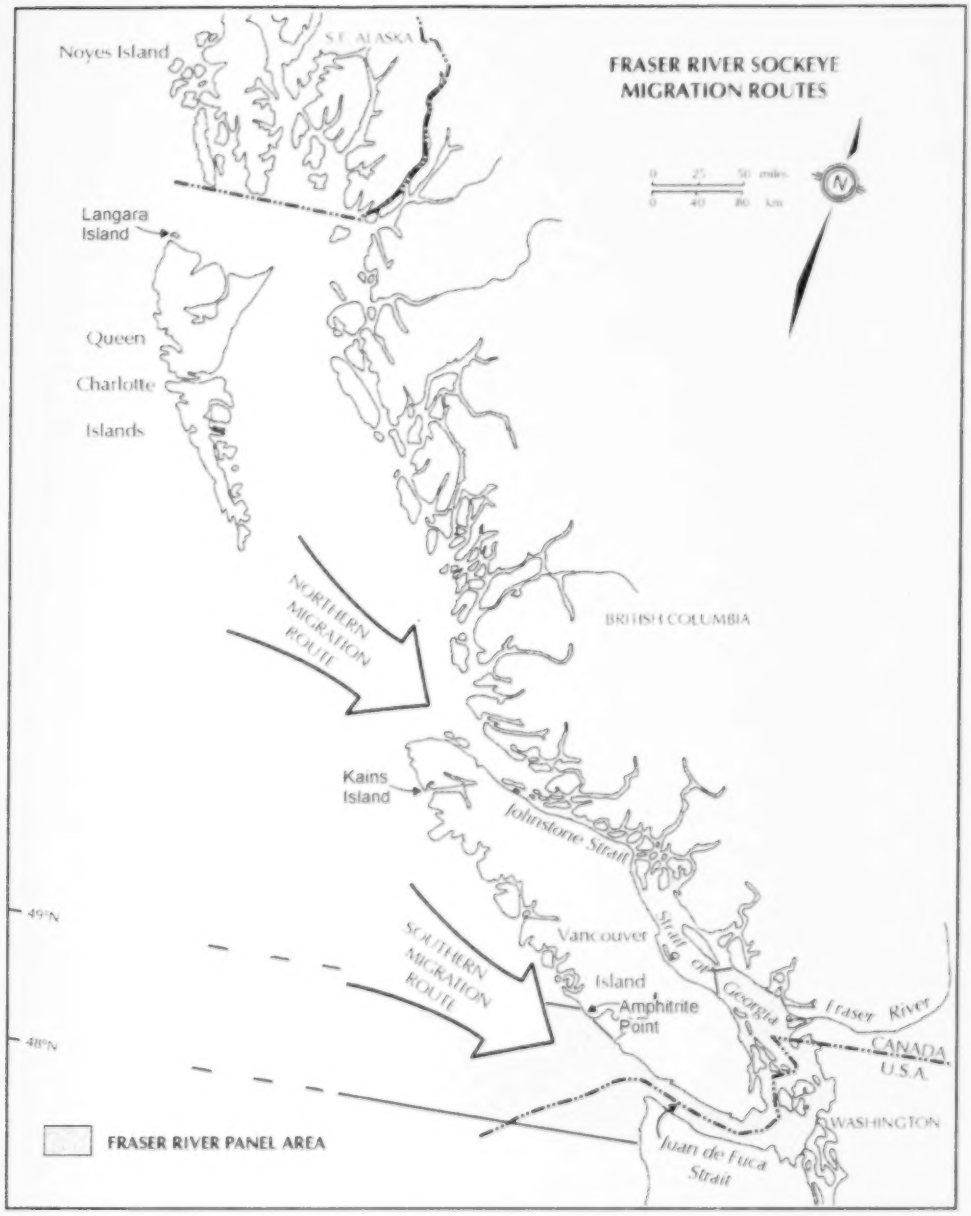

Figure 5. The northern (Johnstone Strait) and southern (Juan de Fuca Strait) routes for sockeye and pink salmon migrating to the Fraser River.

C. In-season Regulations

Between June 28 and September 18, the Fraser River Panel conferred 27 times (by telephone or in-person) to discuss run status and enact in-season Orders (Appendix F) to regulate fisheries directed at the harvest of Fraser River sockeye and pink salmon in Panel Areas.

The environmental conditions for sockeye and pink salmon that migrated upstream of Mission in 2001 were generally favourable, with water temperatures and flow rates being relatively normal except for a period of high discharge from July 21-25. However, Late-run sockeye followed the migratory behaviour of recent years (1996-2000) and instead of delaying for an extended period (4-6 weeks) in the Strait of Georgia, they migrated directly into the Fraser River, and experienced extremely high mortality rates (as in 2000).

The main events of the season are summarized on a weekly basis below. This synopsis focuses on analyses and recommendations by PSC staff, and on Panel decisions.

The first in-season meeting of the Panel took place on June 28. PSC staff discussed the implications of the proportions of age 4 (30% contribution) and age 5 (70% contribution) Early Stuart sockeye present in Area 20 test fishing catches. On this cycle line, the Early Stuart return is normally comprised of greater than 90% age 4 fish. The low proportion of age 4 fish suggested either a weak return or late timing of the age 4 component.

At meetings on July 3 and 6, the Panel was advised that the Early Stuart age 4 sockeye return appeared to be very weak for the cycle line, while the age 5 return was relatively strong and comprised over 50% of the run. The arrival timing of Early Stuart sockeye was estimated to be approximately four days earlier than forecast. On July 6, the Panel adopted an in-season run-size estimate of 250,000 Early Stuart sockeye, although there was high uncertainty associated with the estimate. The staff informed the Panel that the Early Summer-run age 5 sockeye return strength also appeared to be above expectations, and that the timing of these fish would likely be early. The Panel emphasized the need to assess the timing of Early Summer-run sockeye quickly since this assessment would establish the two-week fishery closure period in each area for these fish. On July 10, the staff advised the Panel that the Early Summer-run timing appeared to be three to four days early, and the run size would likely reach or exceed the 50% probability level forecast of abundance (202,000 fish). The Panel approved a staff recommendation that the fishery closure period for Early Summer-run would be from July 10 to July 23 (timing through Area 20). The dates of the closure in other Panel Area waters were also to be adjusted to compensate for the projected run timing of Early Summer-run sockeye being four days earlier than average.

At the meeting on July 13, the Panel approved a further reduction in the Early Stuart run-size estimate to 230,000 sockeye in response to revisions in the racial analyses. The Early Stuart return was still estimated to be four days earlier than average, with age 5 fish contributing over 50% of the returning adults. Early Summer-run sockeye continued to track above the pre-season 50% probability level forecast while run timing was approximately four days earlier than average. While some age 5 Summer-run fish were present in Area 20 test fishing catches, the staff informed the Panel that a higher proportion of age 4 Summer-run sockeye should be expected by this time if the Summer-run age 4 return strength was to reach the 50% probability level forecast of abundance.

By July 17, the abundance of Early Stuart sockeye in marine areas was declining rapidly, while Early Summer-run sockeye were present in higher than expected proportions. Although it was difficult to assess the timing and return strength of Early Summer-run sockeye, analyses indicated the total run was in the range of 200,000 to 300,000 fish. Early indicators suggested that the Summer-run return was tracking below expectations in proportions and abundance for the date. Concerns over the strength of Summer-run sockeye were increasing by the July 20 meeting because age 5 sockeye proportions in Area 20 exceeded 50% and marine test fishing indices and Mission escapements were below anticipated levels. Based on the advice of staff, the Panel adopted a run size of 250,000 Early Summer-run sockeye for planning purposes.

Summer-run sockeye comprised approximately 85% to 90% of the migration in Areas 12 and 20 by July 24. The proportions of age 5 fish in samples ranged from 27% to 39%, which was higher than expected. Staff were not yet able to accurately assess the Summer-run return strength, but informed the Panel that the run was tracking near the 75% probability level forecast of abundance (6,200,000 fish) and with a run timing three days earlier than average. While run-size estimates for Early Summer-run sockeye ranged from 250,000 to 325,000 fish, staff advised the Panel to retain a run size of 250,000 fish. The Panel approved a Treaty Indian fishery in Areas 4B, 5 and 6C since current data indicated that a TAC on Summer-run sockeye was available and the fishery closure window on Early Summer-run sockeye had passed. The Panel was also apprised of a potential disruption in the migration of sockeye through the Fraser Canyon caused by high water flows. The Fraser River was reported to be extremely turbid, and the discharge at Hope had increased rapidly from 4,200 cms on July 20 to 7,200 cms on July 23.

The staff informed the Panel on July 27 that it would not be possible to continue tracking Early Summer-run sockeye due to the low abundance of these stocks relative to Summer-run sockeye. The run-size estimate for Early Summer-run sockeye remained unchanged at 250,000 fish and timing was assessed to be four to five days early. The proportion of age 5 Summer-run sockeye had been declining in response to increasing abundances of Chilko and Quesnel sockeye; both comprised primarily of age 4 fish. Summer-run sockeye assessment remained close to the 75% probability level forecast of abundance, assuming a 50% timing date in Area 20 of August 5. The Johnstone Strait diversion rate was projected to be in the 20% to 40% range. The staff recommended proceeding with some fisheries, even though there was uncertainty in the amount of Summer-run TAC available. There was concern that if commencement of fishing was delayed, the 17% harvest rate ceiling on Late-run stocks would be reached too quickly, thereby compromising the ability to harvest a reasonable proportion of the Summer-run TAC. Based on these considerations, the Panel approved an Area H troll fishery in Canada and the extension of the Treaty Indian fishery in Areas 4B, 5 and 6C, but did not approve higher impact fisheries proposed for Areas 6, 7 and 7A because of Canada's concern over the high uncertainty regarding the available Summer-run TAC.

On July 30, PSC staff reported to the Panel that Summer-run stocks continued to predominate in racial analyses, and while the proportion of age 5 sockeye continued to decline, it was still unexpectedly high. Relatively high catch rates in the Area 29 Area H troll fishery suggested that some Summer-run sockeye were delaying off the mouth of the Fraser River. Difficulty in accurately estimating the potential delay compromised the staff's ability to assess the Summer-run return strength. Estimates of the Summer-run return, without incorporating projections of delaying sockeye, ranged from 3,000,000 to 4,500,000 fish. The estimates were substantially higher when assumptions about delaying fish were included in the estimates. The staff recommended that the Panel adopt a provisional run-size estimate of 5,000,000 Summer-run sockeye, with an Area 20 timing of August 5, which was four days later than the pre-season forecast. The Panel deferred the decision on adopting the above provisional run size on Summer-run sockeye. The Panel approved the following fisheries: In United States Panel Area waters: a Treaty Indian fishery in Areas 4B, 5 and 6C, a Treaty Indian fishery in Areas 6, 7 and 7A and a Non-Indian fishery in Areas 7 and 7A; and in Canadian Panel Area waters: an Area H troll fishery. The staff recommended that a proposed demonstration commercial fishery in Area 20 not proceed because if Summer-run abundance was less than 5,000,000 fish there was not sufficient TAC to allow purse seine fisheries to proceed in both Johnstone Strait and Area 20.

The Panel met in an unscheduled meeting on August 1 to discuss the implications of several factors: (1) stronger than expected catches in the on-going fisheries in United States Panel area fisheries; (2) the lack of significant movement of delaying sockeye past Mission; and (3) the increased sockeye migration past Hell's Gate, which suggested that fish delayed from earlier high river discharge. Catch projections from the United States fisheries suggested a potential sockeye delay in the Strait of Georgia of up to 500,000 fish. Incorporating this projected delay in run-size models generated estimates of 5,000,000 to 6,000,000 Summer-run sockeye, with a 50% migration date in Area 20 of August 5. The Panel adopted a provisional run-size estimate of 6,000,000 Summer-run sockeye and approved an Area B purse seine fishery in Area 20 to harvest surplus Summer-run sockeye prior to significant abundances of Late-run sockeye arriving. A discussion ensued on whether the 50% or 75% probability level forecast should be used for Late-run sockeye

for the purpose of calculating TAC for setting the 17% exploitation rate catch limit. However, an agreement was not reached on this issue.

By early August a trend was emerging in the migration patterns of the Early Stuart and Early Summer-run timing groups. The proportion of age 5 fish had shown initial strength, with the proportion of age 4 fish increasing over time. In addition, the daily abundances of both runs was lower than expected, but the run durations were more protracted than normal. Summer-run sockeye were exhibiting a similar trend, with greater than expected abundance in the age 5 component and a later build-up of the age 4 component. On August 3, the Panel discussed the appropriate run-size forecast of Late-run sockeye to use for in-season calculation of TAC. The Panel agreed, without prejudice to future decisions on the Late-run TAC issue, to not establish a Late-run TAC prior to in-season estimation of abundance but to proceed with fishing on the basis of the Summer-run harvest rate calculations, under the condition that the Late-run exploitation rate would not exceed 17%. The staff advised the Panel that the apparent Summer-run delay in the Strait of Georgia appeared to be less than previously estimated. While the staff did not recommend a change to the provisional run size estimate for Summer-run sockeye, current data indicated the run was likely closer to 5,000,000 fish than to 6,000,000 fish. This necessitated a cautious approach to fishery recommendations. Consequently, the Panel approved two low impact fisheries in United States Panel waters, a Treaty Indian fishery in Areas 4B, 5 and 6C, and a Non-Indian reefnet fishery in Areas 7 and 7A.

At a meeting on August 6, PSC staff informed the Panel that catches in United States fisheries from the prior week were lower than first projected, and that the abundance of Summer-run sockeye had not increased as rapidly as anticipated in marine test fishing and in the escapement passing Mission. In particular, because of the poor age 4 returns to the Quesnel/Chilko stock group, these stocks appeared to be weaker relative to forecasts than the Late Stuart/Stellako stock group. The staff cautioned that the best estimate of Summer-run sockeye was approximately 5,000,000 fish, and the run may be lower if the second mode of the Quesnel migration was lower than being projected.

On August 8, high uncertainty in the run-size estimation of Summer-run sockeye remained. Observations of water-marked sockeye in river test fishing catches and reports of sockeye holding in the Strait of Georgia, combined with prior assessment data, caused the staff to project that approximately 200,000 to 500,000 Summer-run sockeye were continuing to delay. Run-size estimates were in the 4,000,000 to 5,000,000 fish range, but were confounded by uncertainty in the number of fish that were holding in the Strait of Georgia. The Panel approved a conservative, interim run-size estimate of 4,000,000 Summer-run sockeye, which eliminated the availability of additional commercial catch. PSC staff advised the Panel that the gross escapement goal for Early Summer-run sockeye would be exceeded by approximately 82,000 fish, and recommended that this number be considered as management imprecision in TAC calculations. The Panel approved an accounting-based increase in the run size estimation of Early Summer-run sockeye to 325,000 fish.

On August 10, PSC staff advised the Panel that Late-run sockeye had been identified in test fishing samples collected in the Fraser River, which raised the possibility that early upstream migration of Late-run sockeye had begun. Based on current assessments, the Panel approved a Summer-run abundance estimate of 4,000,000 fish. At a Panel update on August 13 the staff reported that the Summer-run timing group continued to indicate a run size of approximately 4,000,000 fish. Individual model estimates ranged from 3,300,000 to 4,700,000 fish, with the Late Stuart/Stellako stock group comprising approximately 1,000,000 fish, and the remainder being from the Quesnel/Chilko stock group. The staff recommended increasing the run-size estimate of Late-run sockeye from 370,000 to 420,000 fish because the Harrison River stock was expected to contribute approximately 50,000 sockeye and had not been included in the pre-season forecast. The Panel deferred a decision on this issue.

At a Panel meeting on August 17, PSC staff reported that the recent assessment of the return strength of Summer-run sockeye indicated a larger abundance than projected the previous week. However, the non-normality of the run distribution (Figure 2) made it difficult to generate accurate estimates of the run size. By using an accounting-based methodology and projecting additional

fish to come based on the Summer-run timing distribution from the last three cycle years, a run size estimate of 5,000,000 fish was derived. An accounting-based estimate was also used to support a Late-run estimate of 480,000 fish, including 250,000 Weaver/Portage, 100,000 Harrison and 130,000 Birkenhead/Adams sockeye. With a Summer-run return of 5,000,000 sockeye, commercial catch was available for both Canadian and United States fishers. However, the harvest rate limit of 17% on Late-run sockeye constrained the remaining catch on true Late-run sockeye to approximately 15,000 fish. Racial analyses indicated that true Late-run sockeye comprised about 10% of the daily migration in marine areas and the Fraser River. Therefore, the Late-run harvest rate limit constrained the Summer-run harvest to approximately 150,000 fish. This limited the ability of the staff to recommend fisheries to harvest the available Summer-run TAC, and the Panel was informed that the resulting inadvertent escapement of Summer-run stocks could reach 500,000 fish. The Panel approved an increase in the Summer-run abundance to 5,000,000 fish and a Late-run return of 480,000 fish for management purposes. The Panel approved a United States Non-Indian reefnet fishery in Areas 7 and 7A, subject to a catch ceiling of 9,000 sockeye.

At an August 20 Panel meeting, PSC staff informed the Panel that Late-run sockeye continued to migrate directly into the Fraser River with virtually no delay, and as a consequence high en route and pre-spawning mortalities were likely. The Late-run abundance estimate remained at 480,000 fish, including 350,000 true Late-run sockeye. At this run size, the United States allocation of true Late-run sockeye was 9,200 fish, and their current catch was estimated at approximately 9,300 fish. This precluded the staff from making additional fishery recommendations for United States Panel waters. In Canada a bycatch allocation of 11,600 true Late-run fish remained for harvest.

At an August 24 Panel meeting PSC staff advised the Panel to retain the estimate of 5,000,000 Summer-run sockeye, which included approximately 1,000,000 Late Stuart/Stellako, 1,000,000 Chilko and 3,000,000 Quesnel sockeye. Late-run catch and escapement totalled 390,000 fish with additional fish en route. The Panel approved a revision of the Late-run sockeye run-size estimate of 550,000 fish, including projections of 150,000 Birkenhead/Adams, 300,000 Weaver/Portage and 100,000 Harrison sockeye. The staff expressed strong concern about the continued lack of delay of Late-run sockeye in the Strait of Georgia.

At the August 28 Panel meeting, PSC staff reported that sockeye escapements during the prior four days were larger than projected, and the accounted Summer-run total had reached 4,600,000 fish in catch plus escapement. In addition, the migration of sockeye past the Area 12 and 20 test fishing sites had increased. The staff advised the Panel that the Summer-run return would likely exceed 5,000,000 fish by a small amount. The accounted Late-run total abundance was currently 496,000 sockeye, with an additional 80,000 fish projected between the marine area test fishery locations and the Fraser River. The Panel was advised that run size updates would be provided at the next Panel meeting. The staff noted that it was too early in the migration of Fraser River pink salmon to assess their abundance, and therefore it was premature to consider fishing opportunities. The early upstream migration of Late-run sockeye was reviewed, and the prognosis was not encouraging. Late-run sockeye continued to migrate into the Fraser River without delaying in the Strait of Georgia, and large schools of Late-run Weaver and Harrison sockeye had been reported in Harrison River and Harrison Lake.

At the August 31 meeting, PSC staff revised recent sockeye escapement estimates because of problems in the estimation of species composition. To address the problem, staff recommended use of the Whonnock test fishery CPUE data for recent days, and for future assessments. The Panel approved accounting-based estimates of sockeye run size of 5,300,000 Summer-run and 600,000 Late-run sockeye. The Late-run total was projected to include 160,000 Birkenhead/Adams, 340,000 Weaver/Portage and 100,000 Harrison sockeye. The staff also presented a range of model estimates of the Fraser River pink salmon run size. The estimates ranged from approximately 7,000,000 to 10,000,000 fish. The Panel approved a provisional Fraser River pink salmon run size of 7,000,000 fish. The Panel also agreed that the Summer-run escapement in excess of the goal was due to management imprecision, and would be dealt with during post-season accounting. Finally, the Panel approved United States Treaty Indian purse seine fisheries, and Non-Indian purse seine and reefnet fisheries for Fraser River pink salmon in

Areas 7 and 7A, with the non-retention of sockeye and other species, and with the Iwersen's Dock Line boundary restriction imposed.

At the September 5 Panel meeting the Panel approved the pink salmon run size increase to 8,000,000 fish, based on catches and test fishing results. They also approved a Non-Indian reefnet fishery in Areas 7 and 7A, with non-retention of sockeye and other species, and with the Iwersen's Dock Line in effect. At the meeting the United States entered a statement into the record, stating that the conservation actions being taken in United States Panel area waters with respect to pink salmon were not to be considered precedent setting for future years (Appendix G). At a Panel meeting on September 7, the Panel approved additional pink salmon fisheries, including a Treaty Indian purse seine fishery in Areas 7 and 7A, and Non-Indian purse seine and reefnet fisheries in Areas 7 and 7A. For all fisheries the non-retention of sockeye and other species, and the Iwersen's Dock Line were in effect.

At a September 11 meeting the staff reported that a large abundance of pink salmon had been identified in United States Panel waters, and that large migrations of pink salmon were being reported both at the Mission hydroacoustic site and at the Duncan Bar tagging site. The run-size models projected Fraser River pink salmon abundance at between 10,000,000 and 14,000,000 fish. The Panel approved an increase in the Fraser River pink salmon run size estimate to 10,000,000 fish. The Panel also approved a Treaty Indian purse seine fishery and Non-Indian purse seine and reefnet fisheries in Areas 7 and 7A, which were directed at pink salmon. The non-retention of sockeye and other species, and the Iwersen's Dock Line were in effect for these fisheries.

On September 17, the staff reviewed the Summer-run and Late-run sockeye accounting estimates that indicated the Summer-run return would likely reach 5,100,000 fish, and the Late-run return would reach approximately 560,000 fish. Both estimates were slightly lower than previous estimates for these timing groups. However, the Panel did not take action to change the total return estimates for Summer-run and Late-run sockeye since most fisheries had ceased. The Panel approved a Treaty Indian purse seine fishery and a Non-Indian reefnet fishery in Areas 7 and 7A for the harvest of pink salmon. For both fisheries the non-retention of sockeye and other species, and the Iwersen's Dock Line were in effect. On September 18, the Panel expanded the regulations from the prior day to include a Non-Indian purse seine fishery in Areas 7 and 7A, with the same constraints regarding species retention and area restrictions. Finally, regulatory control in Fraser River Panel waters was relinquished as per the pre-season schedule.

Commercial fishing times in Canadian Panel Areas are shown in Table 2. No gillnet fishing was scheduled in Area 20 due to coho conservation concerns. During the week of August 5 to 11, four days of purse seine fishing were scheduled in Area 20 for international and domestic sockeye allocation purposes. These fisheries had the requirement that participating vessels possess a "Scientific License", with DFO adjusting the duration and open hours of the fishery as required on the fishing grounds, based on coho and chinook salmon encounters. However, factors associated with low catches led purse seine operators to limit fishing to two days. No gillnet fishing was scheduled in Area 29 during the sockeye salmon fishing period. Area H troll fisheries were scheduled in Areas 29 and 18, for periods of one day during the week of July 22 to 28, and four days during the week of July 29 to August 4. Canada regulated commercial fisheries in non-Panel Area waters in coordination with Panel management.

Net fishing times in United States Panel Areas are shown in Table 3. These fisheries were conducted to meet the international and domestic allocation obligations of the Panel. The Treaty Indian fishery in Areas 4B, 5 and 6C was open for a total of 186 hours during the period from July 25 to August 4. The Treaty Indian fishery in Areas 6, 7 and 7A was open once for directed sockeye fishing, from July 31 to August 1 for a total of 26 hours. In addition, the Treaty Indian purse seine gear in Areas 7 and 7A was open for directed pink salmon harvest, with non-retention of sockeye, for 80 hours during the September 2-22 time period. Effort was low, only one to three purse seines fished per day in these openings. Non-Indian gillnet fishery in Areas 7 and 7A was open for 16 hours for directed sockeye harvest between July 31 and August 1. Non-Indian purse seines had 15 hours of sockeye fishing on August 1, while the Non-Indian reefnets had 16 hours of sockeye fishing in each of three consecutive weeks, July 29 to August 4, August 5 to 11, and August 12 to 18. Non-Indian purse seines were open for pink salmon harvest, with non-retention

of sockeye, for 80 hours during the period September 2-22. Non-Indian reefnets were open for pink salmon harvest, with non-retention of sockeye, for 352 hours during the period between August 26 and September 22. Non-Indian purse seine effort was low in pink salmon fisheries: 1-20 vessels fished each day.

Table 2. Actual fishing times (days) in major Canadian fisheries in the Fraser River Panel Area in 2001.

	Area 20		Area 29	Areas 18, 29
Date	Purse Seine	Gillnet	Gillnet	Troll
Jun.24-Jul.21	Closed	Closed	Closed	Closed
Jul.22-Jul.28	Closed	Closed	Closed	1
Jul.29-Aug.4	Closed	Closed	Closed	4
Aug.5-Aug.11	4 *	Closed	Closed	Closed
Aug.12-Aug.18	Closed	Closed	Closed	Closed
Aug.19-Aug.25	Closed	Closed	Closed	Closed
Aug.26-Sep.1	Closed	Closed	Closed	Closed
Sep.2-Sep.8	Closed	Closed	Closed	Closed
Sep.9-Sep.15	Closed	Closed	Closed	Closed
Sep.16-Sep.22	Relinq.	Relinq.	Closed	Closed
Sep.23-Sep.29			Closed	Closed
Sep.30-Oct.6			Closed	Relinq.
Oct.7-Oct.13			Closed	
Oct.14-Oct.20			Relinq.	
Total	4	0	0	5

* Short duration "scientific license" fisheries.

Table 3. Actual fishing times (hours) in major United States net fisheries in the Fraser River Panel Area in 2001.

	Treaty Indian		Non-Indian		
	Areas	Areas	Areas 7 and 7A		
Date	4B, 5, 6C	6, 7, 7A	Purse Seine	Gillnet	Reefnet
Jun.24-Jul.21	Closed	Closed	Closed	Closed	Closed
Jul.22-Jul.28	84	Closed	Closed	Closed	Closed
Jul.29-Aug.4	102	26	15	16	16
Aug.5-Aug.11	Closed	Closed	Closed	Closed	16
Aug.12-Aug.18	Closed	Closed	Closed	Closed	16
Aug.19-Aug.25	Closed	Closed	Closed	Closed	Closed
Aug.26-Sep.1 *	Closed	Closed	Closed	Closed	16
Sep.2-Sep.8 *	Closed	16	16	Closed	112
Sep.9-Sep.15 *	Closed	48	48	Closed	112
Sep.16-Sep.22 *	Relinq.	16	16	Closed	112
Sep.23-Sep.29		Relinq.	Relinq.	Relinq.	Relinq.
Total	186	106	95	16	400

* Non-retention of sockeye during pink salmon-directed fisheries.

V. CATCH SUMMARY

A. Sockeye Salmon

The total adult return in 2001 of 7,213,000 Fraser River sockeye salmon (Table 4) was 44% below the pre-season run-size 50% probability level forecast of 12,865,000 fish, but close to the 75% probability level forecast (6,798,000 fish). In the previous 12 returns on the 2001 cycle line (1953 to 1997), sockeye abundance has ranged from a low of 3,167,000 fish (1965) to a high of 23,631,000 fish (1993). The 2001 return was the smallest return on the line since 1977, and was below the long-term average for the line of 9,756,000 fish (Figure 6). The commercial exploitation rate (8 %) was the lowest for this cycle over the period of record (i.e., since 1953); the second lowest commercial exploitation rate on this cycle (63.1%) was recorded in 1997. Conversely, the 2001 spawning escapement formed the highest percentage (73.2%) of the run on record.

Catches of Fraser River sockeye salmon in all fisheries totalled 1,604,000 fish (Table 4). Canadian catches of 1,197,000 sockeye included a commercial harvest of 262,000 fish, a selective fishery catch of 35,000 fish, a First Nation's catch of 848,000 fish and miscellaneous non-commercial catches of 52,000 sockeye. United States fishers caught 284,000 fish, including a commercial harvest of 273,000 sockeye and a ceremonial and subsistence catch of 11,000 fish. In addition to the catches outlined above, test fisheries authorized by the Fraser River Panel landed 123,000 sockeye.

Near-final estimates of spawning escapements totalled 5,256,000 adult sockeye, while an estimated 331,000 Late-run sockeye died between Mission and the spawning grounds due to disease factors related to the early upstream migration behaviour of these stocks.

i. Canada

The commercial catch in Canada was 262,000 fish, including 99,000 fish in Panel Areas and 163,000 fish in non-Panel Areas, while the selective fishery catch was 34,000 fish in Panel Areas and 1,000 fish in non-Panel Areas. Non-commercial catches included DFO charter catches of 12,000 fish, an ESSR catch of 3,000 fish and recreational catches of 3,000 and 34,000 fish in marine and Fraser River areas, respectively.

Estimates of Canadian commercial catches of Fraser River sockeye salmon by gear type and area are presented in Table 5. Area B (southern) purse seines caught 78,000 sockeye (26% of the Canadian commercial catch), Area D (Johnstone Strait) gillnets caught 94,000 sockeye (32% of the commercial harvest) and Area E (Fraser River) gillnets caught 44,000 (15% of the commercial share). Within the troll gear sector, Area G (outside) trollers caught 20,000 sockeye (7% of the commercial harvest), and Area H (inside) trollers caught 61,000 sockeye (20% of the commercial share). Weekly catches in Canadian fishing areas are shown in Appendix H (Tables 1-4). Selective fishery catches totalled 3,000 by Area B (southern) purse seines and 32,000 by Area E (Fraser River) gillnets.

First Nations fishers caught 848,000 sockeye, including 184,000 fish harvested in marine fisheries and 664,000 fish in the Fraser River (Appendix H, Table 5). The catch distribution in the Fraser River was as follows: 182,000 fish in the Fraser River below Mission; 222,000 fish harvested in the Fraser River between Mission and Sawmill Creek; and 260,000 fish in the mainstem of the Fraser River and in tributaries upstream of Sawmill Creek. Pilot sales fisheries accounted for 175,000 of the catch below Sawmill Creek.

Table 4. Preliminary estimates of fishery catches, spawning escapement and total run of Fraser River sockeye salmon during the 2001 fishing season, by country and area.

	Number of Fish	% of Run
CANADA		
COMMERCIAL CATCH		
Fraser River Panel Area		
Areas 121-124 Troll	16,000	
Area 20 Net	46,000	
Areas 17-18 and 29 Troll	25,000	
Area 29 Net	12,000	
Total	99,000	1.4%
Non-Panel Areas		
Areas 1-10 Troll and Net	0	
Areas 11-16 Troll and Net	163,000	
Areas 124-127 Troll	0	
Total	163,000	2.3%
Selective Fisheries	35,000	0.5%
Commercial Total	297,000	4.1%
FIRST NATIONS CATCH		
Marine Areas - food, social, ceremonial		
Areas 12-16, 18, 20, and 123-126	114,000	
Area 29-1 to 7	70,000	
Total	184,000	2.6%
Fraser River - food, social, ceremonial		
Below Sawmill Creek	229,000	
Above Sawmill Creek	260,000	
Total	489,000	6.8%
Pilot Sales	175,000	2.4%
First Nations Total	848,000	11.8%
NON-COMMERCIAL CATCH		
ESSR Fishery *	3,000	
Charter	12,000	
Recreational Fishery - Marine	3,000	
Recreational Fishery - Above Mission	34,000	
Non-Commercial Total	52,000	0.7%
CANADIAN TOTAL	1,197,000	16.6%
UNITED STATES		
COMMERCIAL CATCH		
Fraser River Panel Area		
Areas 4B, 5 and 6C Net	35,000	
Areas 6 and 7 Net	96,000	
Area 7A Net	99,000	
Total	230,000	3.2%
Non-Panel Areas		
Alaska Net	43,000	0.6%
Commercial Total	273,000	3.8%
NON-COMMERCIAL CATCH		
Ceremonial & Subsistence	11,000	0.2%
UNITED STATES TOTAL	284,000	3.9%
TEST FISHING		
COMMISSION		
Areas 20 and 29 Test Fishing	93,000	
Area 7 Test Fishing	0	
Commission Total	93,000	1.3%
CANADA		
Areas 12 and 13 Test Fishing	30,000	0.4%
TEST FISHING TOTAL	123,000	1.7%
TOTAL CATCH	1,604,000	22.2%
SPAWNING ESCAPEMENT	5,278,000	73.2%
DIFFERENCE BETWEEN ESTIMATES **	331,000	4.6%
TOTAL RUN	7,213,000	100.0%

* Harvest of Weaver Creek sockeye in the terminal area that were Excess Salmon to Spawning Requirements (ESSR).

** [Mission escapement + First Nations catch below Mission] - [total Fraser River First Nations catch, in-river recreational catch & spawning escapement], for Late-run stocks.

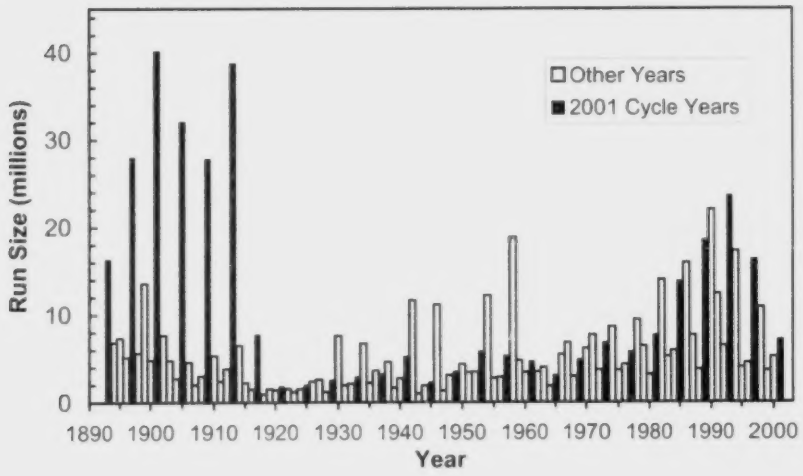

Figure 6. Total run sizes of Fraser River sockeye salmon between 1893-2001. Returns on the 2001 cycle are emphasized.

Table 5. Preliminary estimates of Canadian commercial catches of Fraser River sockeye salmon by gear type, license designation and statistical area during the 2001 fishing season. *

	Purse Seine		Gillnet			Troll			
Areas	Area A	Area B	Area C	Area D	Area E	Area F	Area G	Area H	Total
1-10	0		0			0			0
11-16		30,000		94,000	0		4,000	36,000	164,000
121-127		0		0			16,000		16,000
20		48,000			0		0		48,000
17, 18, 29		0			44,000			25,000	69,000
Total Catch	0	78,000	0	94,000	44,000	0	20,000	61,000	297,000
% of Catch	0.0%	26.3%	0.0%	31.6%	14.8%	0.0%	6.7%	20.5%	100.0%

* DFO preliminary post-season catch estimates.

ii. United States

Catches of Fraser River sockeye in the United States totalled 284,000 fish in 2001, 230,000 fish in Panel Area commercial fisheries and 11,000 fish in ceremonial and subsistence fisheries (Table 6). Treaty Indian fishers harvested 172,000 fish in commercial fisheries, including a catch of 37,000 fish in Areas 4B, 5 and 6C, and 135,000 fish in Areas 6, 7 and 7A. Non-Indian catches totalled 69,000 sockeye, including 40,000 fish by purse seines, 20,000 fish by gillnets and 9,000 sockeye by reefnets. Weekly catches of Fraser River sockeye salmon in United States Panel Areas are shown in Appendix H (Table 6).

Table 6. Preliminary estimates of United States commercial catches of Fraser River sockeye salmon by user group, gear type and statistical area during the 2001 fishing season. *

Areas	Ceremonial & Subsistence	Purse Seine	Gillnet	Reefnet	Total
Treaty Indian					
4B, 5 and 6C	2,000	0	35,000	0	37,000
6 and 7	1,000	50,000	19,000	0	70,000
7A	8,000	20,000	37,000	0	65,000
6, 7 and 7A Total	9,000	70,000	56,000	0	135,000
% of Catch	6.7%	51.9%	41.5%	0.0%	100.0%
Total Catch	11,000	70,000	91,000	0	172,000
% of Catch	6.4%	40.7%	52.9%	0.0%	100.0%
Non-Indian					
7	0	9,000	9,000	9,000	27,000
7A	0	31,000	11,000	0	42,000
Total Catch	0	40,000	20,000	9,000	69,000
% of Catch	0.0%	58.0%	29.0%	13.0%	100.0%
United States					
Panel Area Total	11,000	110,000	111,000	9,000	241,000
Alaska (District 104) Catch					43,000
Total Catch					284,000

* Washington catches from Washington Department of Fish and Wildlife "soft system".

B. Pink Salmon

The total return of 21,293,000 Fraser River pink salmon (Table 7) was almost four times the pre-season 50% probability level forecast of 5,468,000 fish. The run was the second largest since 1959 (Figure 7). Catches in all fisheries totalled 1,450,000 fish: 967,000 in Canadian, 445,000 in United States, and 38,000 in Panel-approved test fisheries.

Table 7. Preliminary estimates of fishery catches, spawning escapement and total run of Fraser River pink salmon during the 2001 fishing season, by country and area.

	Number of Fish	% of Run
CANADA		
COMMERCIAL CATCH		
Fraser River Panel Area		
Areas 121-124 Troll	6,000	
Area 20 Net	8,000	
Areas 17-18 and 29 Troll	0	
Area 29 Net	0	
Total	14,000	0.1%
Non-Panel Areas		
Areas 1-10 Troll and Net	0	
Areas 11-16 Troll and Net	731,000	
Areas 124-127 Troll	2,000	
Total	733,000	3.4%
Selective Fisheries	10,000	0.0%
Commercial Total	757,000	3.6%
FIRST NATIONS CATCH		
Marine Areas - food, social, ceremonial		
Areas 12-16, 18, 20, and 123-126	16,000	
Area 29-1 to 7	0	
Total	16,000	0.1%
Fraser River - food, social, ceremonial		
Below Sawmill Creek	3,000	
Above Sawmill Creek	0	
Total	3,000	0.0%
Pilot Sales	115,000	0.5%
First Nations Total	134,000	0.6%
NON-COMMERCIAL CATCH		
Recreational Fishery - Marine	74,000	
Charter	2,000	
Non-Commercial Total	76,000	0.4%
CANADIAN TOTAL	967,000	4.5%
UNITED STATES		
COMMERCIAL CATCH		
Fraser River Panel Area		
Areas 4B, 5 and 6C Net & Troll	6,000	
Areas 6 and 7 Net	264,000	
Area 7A Net	156,000	
Total	426,000	2.0%
Non-Panel Areas		
WA, OR and CA Troll	0	0.0%
Commercial Total	426,000	2.0%
NON-COMMERCIAL CATCH		
Recreational	18,000	
Ceremonial & Subsistence	1,000	
Non-Commercial Total	19,000	0.1%
UNITED STATES TOTAL	445,000	2.1%
TEST FISHING		
COMMISSION		
Areas 20 and 29 Test Fishing	25,000	
Area 7 Test Fishing	0	
Commission Total	25,000	0.1%
CANADA		
Areas 12 and 13 Test Fishing	13,000	0.1%
TEST FISHING TOTAL	38,000	0.2%
TOTAL CATCH	1,450,000	6.8%
SPAWNING ESCAPEMENT	19,843,000	93.2%
TOTAL RUN	21,293,000	100.0%

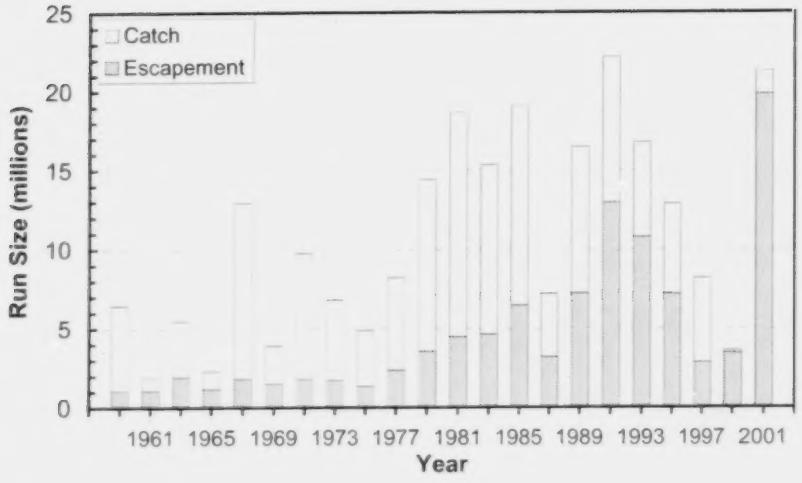

Figure 7. Catch and escapement of Fraser River pink salmon between 1959-2001.

i. Canada

A total of 967,000 Fraser River pink salmon were harvested in commercial, First Nations and non-commercial fisheries in Canada (Table 7). The commercial catch was 757,000 fish, including 14,000 fish from Panel Areas, and 733,000 fish from non-Panel Areas. Selective fisheries in Area B harvested 10,000 Fraser River pink salmon in Areas 11-16.

Estimates of Canadian commercial catches of Fraser River pink salmon by gear type and area are presented in Table 8. Area B (southern) purse seines caught 671,000 Fraser River pink salmon (89% of the Canadian commercial catch), Area D (Johnstone Strait) gillnets caught 7,000 pinks (1% of the commercial harvest), while Area E (Fraser River) gillnets did not have any commercial openings in 2001. Within the troll gear sector, Area G (outside) trollers caught 16,000 pinks (2% of the commercial harvest), and Area H (inside) trollers caught 63,000 pinks (8% of the commercial share). Weekly catches in Canadian fishing areas are shown in Appendix H (Tables 7-10).

First Nations fishers caught 134,000 Fraser River pink salmon: 16,000 fish in marine areas and 117,000 in the Fraser River downstream from Sawmill Creek including 115,000 in Pilot Sales fisheries (Appendix H: Table 11).

Non-commercial catches included DFO charter catches of 2,000 fish, and recreational catches of 74,000 fish.

ii. United States

Catches of Fraser River pink salmon in the United States totalled 445,000 fish in 2001, 426,000 in Panel Area commercial fisheries, 1,000 in ceremonial and subsistence fisheries and 18,000 in recreational fisheries (Table 7). Treaty Indian fishers harvested 109,000 fish in commercial fisheries, including a catch of 6,000 in Areas 4B, 5 and 6C, and 103,000 fish in Areas 6, 7 and 7A (Table 9). Non-Indian catches totalled 317,000 pink salmon, including 310,000 fish by purse seines, 6,000 fish by reefnets, and 1,000 by gillnets. Weekly catches of Fraser River pink salmon in United States Panel Areas are shown in Appendix H (Table 12).

Table 8. Preliminary estimates of Canadian commercial catches of Fraser River pink salmon by gear type, license designation and statistical area during the 2001 fishing season. *

	Purse Seine		Gillnet			Troll			
Areas	Area A	Area B	Area C	Area D	Area E	Area F	Area G	Area H	Total
1-10	0		0			0			0
11-16		662,000		7,000	0		8,000	63,000	740,000
121-127		0		0			8,000		8,000
20		9,000			0		0		9,000
17, 18, 29		0			0			0	0
Total Catch	0	671,000	0	7,000	0	0	16,000	63,000	757,000
% of Catch	0.0%	88.6%	0.0%	0.9%	0.0%	0.0%	2.1%	8.3%	100.0%

* Catch data from DFO ticket sales slips.

Table 9. Preliminary estimates of United States commercial catches of Fraser River pink salmon by user group, gear type and statistical area during the 2001 fishing season. *

Areas	Troll	Purse Seine	Gillnet	Reefnet	Total
Treaty Indian					
4B, 5 and 6C	1,000	0	5,000	0	6,000
6 and 7	0	84,000	0	0	84,000
7A	0	19,000	0	0	19,000
6, 7 and 7A Total	0	103,000	0	0	103,000
% of Catch	0.0%	100.0%	0.0%	0.0%	100.0%
Total Catch	1,000	103,000	5,000	0	109,000
% of Catch	0.9%	94.5%	4.6%	0.0%	100.0%
Non-Indian					
7	0	174,000	0	6,000	180,000
7A	0	136,000	1,000	0	137,000
Total Catch	0	310,000	1,000	6,000	317,000
% of Catch	0.0%	97.8%	0.3%	1.9%	100.0%
United States					
Panel Area Total	1,000	413,000	6,000	6,000	426,000
Non-Panel Area Total					0
Total Catch					426,000

* Washington catch data from Washington Department of Fish and Wildlife "soft system".

VI. STOCK MONITORING

The purpose of the stock monitoring program is to assess run size, daily abundance and migration timing of Fraser River sockeye and pink salmon at different points along their migration route during the fishing season. In addition, diversion rate via Johnstone Strait is assessed weekly during the in-season period. This information is required for developing fishing plans to attain annual escapement and catch allocation objectives.

Run-size estimation for Fraser River sockeye (by stock group) and pink salmon is based primarily on catch, effort, escapement, racial composition, run timing and diversion rate data. Most of these data for Summer-run and Late-run sockeye have historically been obtained from commercial fisheries. However, limited commercial fishing in recent years has reduced the availability of this information. Therefore, test fishing catch and CPUE data are used more extensively in assessing sockeye and pink salmon abundances, than in previous years. These data are analyzed using catch-per-unit-effort, cumulative-normal and cumulative-passage-to-date models, which are described in reports[1,2]. In addition, a Bayesian "Box-Car" or reconstruction-based model was employed in 2001. This model includes features of the cumulative-normal and cumulative-passage-to-date models, and objectively combines the estimates from its component models based on their relative uncertainty.

Test fisheries (Table 10) conducted by the Commission or DFO at the request of the Commission provided important data before and after the commercial fishing season and between fishing periods. Information about upstream migration in the river was obtained by test fishing in the lower river, echosounding at Mission, visual observations at Hells Gate and analysis of catches in Fraser River First Nations fisheries. The upstream passage of sockeye and pink salmon in 2001 was monitored at Mission from June 21 to September 27. Before September 1, estimates of daily gross escapements of sockeye and pink salmon were derived by combining Mission hydroacoustic data with species composition data from gillnet test fishing at Whonnock (in Area 29-16). After September 1, because of uncertainty about species composition estimates during periods of high pink salmon abundance, a CPUE model based on Whonnock test fishing was used to estimate daily sockeye escapements while the DFO tagging program at Duncan Bar was used to obtain estimates of pink salmon passage. Daily visual observations at Hells Gate between June 28 and October 4 supplied qualitative information about upstream fish passage.

A. Sockeye Salmon

Early Stuart sockeye are the first Fraser River sockeye stock to arrive in coastal waters each year. While 2001 was the dominant cycle line for this stock, high discharge in the Fraser River severely affected the 1997 upstream migration of the brood-year escapement resulting in a low pre-season 50% probability forecast of 420,000 fish (258,000 at the 75% probability level). Analyses in early July indicated the run size was close to the 75% probability level forecast. On July 3, the run size was estimated at 250,000 fish and was subsequently lowered on July 13 to 230,000 sockeye. The 50% cumulative migration date through Area 20 was June 28, which was five days earlier than the long-term average. The run-size estimate for Early Stuart sockeye at the end of the season was 226,000 sockeye and the gross escapement estimate (escapement past Mission plus First Nations' catch below Mission) was 221,000 fish.

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[1] Pacific Salmon Commission. 1995. Pacific Salmon Commission run-size estimation procedures: An analysis of the 1994 shortfall in escapement of Late-run Fraser River sockeye salmon. Pacific Salmon Com. Tech. Rep. No. 6: 179 p.

[2] Pacific Salmon Commission. 1998. Report of the Fraser River Panel to the Pacific Salmon Commission on the 1995 Fraser River sockeye and pink salmon fishing season. Vancouver, B.C., 64 p.

Table 10. Test fishing operations that were approved by the Fraser River Panel for the 2001 fishing season.

Area	Gear	Dates	Operated by
Canadian Panel Areas			
20	Purse Seine	July 24 - September 13	PSC
20	Gillnet	June 19 - August 22	PSC
29-13	Gillnet	July 11 - September 24	PSC
29-16	Gillnet	June 21 - September 7	PSC
29-1 to 6	Troll	August 13 - September 5	PSC
Canadian non-Panel Areas			
12	Gillnet	July 11 - August 13	DFO
12	Purse Seine	July 18 - September 13	DFO
13	Purse Seine	July 18 - August 23	DFO
United States Panel Areas			
7	Reefnet	June 25 - July 24	PSC

In mid-July the management focus shifted to Early Summer-run stocks. The pre-season forecasts for this timing-group were 202,000 fish (50% probability level) and 107,000 fish (75% probability level). By July 10, in-season data indicated that Early Summer-run sockeye were both earlier timed and more abundant than both forecasts. On July 20 run-size estimates ranged between 200,000 to 300,000 fish and the run-size was revised to 250,000 fish. On August 8 the run was estimated at 325,000 fish. Final in-season estimates of Early Summer-run abundance and gross escapement were 313,000 and 293,000 fish, respectively. The date when 50% of Early Summer-run sockeye were estimated to have migrated through Area 20 was July 17, approximately four days earlier than average.

In late July, the Summer-run migration was tracking substantially lower than the 50% probability level forecast (11,715,000 fish) if run timing was normal, and was closer to the 75% probability level forecast (6,159,000 fish). On August 1, in-season run-size estimates that incorporated a delay of up to 500,000 Summer-run sockeye in the Strait of Georgia ranged from 4,800,000 to 8,300,000 Summer-run sockeye and the Panel adopted a provisional run-size estimate of 6,000,000 fish. However, the run size projection was decreased to 4,000,000 fish on August 8 because of low abundance in the marine test fisheries and in the river. The later-timed component of Quesnel sockeye showed strength with a peak in the marine area gillnet and purse seine test fishing catches on August 14. This prompted a subsequent increase in the run-size estimate of Summer-run sockeye to 5,000,000 fish on August 17 and to 5,300,000 sockeye on August 31. By the end of the season, the total Summer-run return was estimated at 5,092,000 fish with a gross escapement of 4,340,000 fish. The 50% cumulative migration date through Area 20 of Summer-run sockeye was August 7, approximately four days later than average.

The pre-season forecasts for Late-run sockeye were 528,000 fish (50% probability level) and 274,000 fish (75% probability level). Assessments of Late-run sockeye abundance were confounded by the much higher abundance of co-migrating Summer-run sockeye. On August 17, the run-size of Late-run sockeye was estimated at 480,000 fish and was revised on August 24 to 550,000 fish. The estimate was increased to 600,000 fish on August 31, based on assessments of very early upstream migration and on sustained abundance observed in the Areas 12, 13, and 20 purse seine test fisheries. By the end of the season, the total run size was estimated at 562,000 fish with a gross escapement of 485,000 fish. The 50% cumulative migration date of the Late-run sockeye through Area 20 was August 12, approximately six days earlier than average.

Sea surface temperatures throughout the north Pacific remained below average in 2001 following cool temperatures in 1999-2000. Based on these low ocean temperatures, the diversion

of sockeye through Johnstone Strait was forecast at 25%. The average Johnstone Strait diversion rate (all Fraser sockeye) for the season was estimated at the end of the season to be between 20 % and 25%.

The pattern of daily migration in the river as measured by Cottonwood test fishing CPUE data, and by estimates of escapement from the Mission hydroacoustic program and the Whonnock test fishing program were similar (Figure 8). Daily migration estimates were obtained using hydroacoustic methods until August 31, after which Whonnock test fishing CPUE models were used. The Cottonwood data were lagged one to two days, which is the estimated travel time for sockeye between the Cottonwood and Mission sites.

Migration conditions for Fraser River sockeye in the Fraser Canyon were adverse during the latter part of July as an increase in discharge from the upper Fraser River basin arrived from July 22 to 25. The discharge at Hope rose from 4,200 cms on July 20, to 7,200 cms on July 23 and the turbidity in the river increased to very high levels during this period. Observations at Hells Gate indicated that the passage of sockeye was delayed during this period presumably due to the high water levels and turbidity and the mortality of some sockeye was anticipated. Further, the high, turbid flows appear to have caused fish approaching the river mouth to delay in the Strait of Georgia. The migration of sockeye proceeded normally after early August.

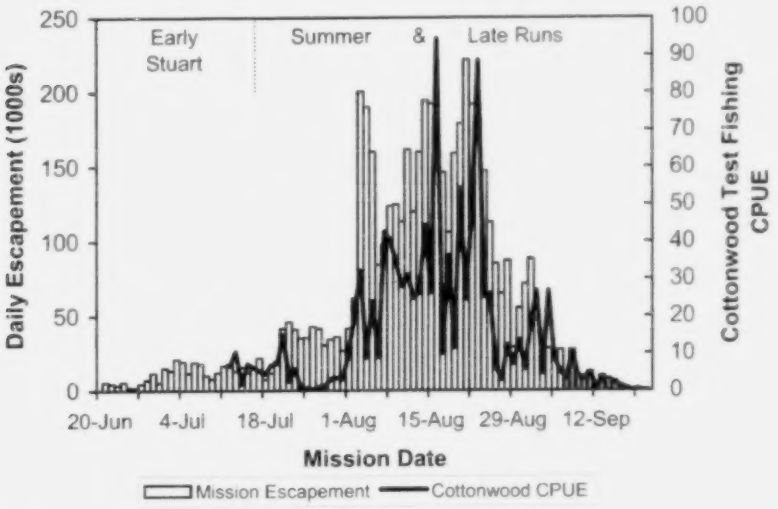

Figure 8. Daily Mission escapements of sockeye salmon estimated by Mission echosounding (before Sept. 7) and Cottonwood test fishing CPUE (Sept. 7-20), compared with test fishing CPUE's at Cottonwood one to two days earlier.

B. Pink Salmon

Assessments of the migration of Fraser River pink salmon in marine areas in 2001 were based primarily on data from purse seine test fisheries because of the shortage of commercial catch data. Consequently, there was lower confidence in the run-size estimates for Fraser River pink salmon. Escapements to the Strait of Georgia were estimated by expansion of CPUE data from the purse seine test fisheries. The proportion of Fraser River pink salmon in these catches were initially estimated using pre-season projections of racial composition. These estimates were later replaced in-season by genetic stock identification (GSI) estimates.

The pre-season forecasts for Fraser River pink salmon were 5,468,000 fish (50% probability level) and 4,049,000 fish (75% probability level) and the peak (50% cumulative passage) date through Area 20 was forecast to be September 2. By the end of August, the run appeared to be slightly earlier than forecast and the total return was estimated at 7,000,000 fish, based on conservative estimates of expansion of CPUE data from the purse seine test fisheries. During the first week of September, purse seine test fishery catches of pink salmon increased rapidly in Areas 12 and 13. On September 5, the run-size was estimated at 8,000,000 fish. On September 11, the run-size estimate was increased to 10,000,000 fish.

The pre-season forecast of the diversion rate of Fraser River pink salmon through Johnstone Strait was 64%. In-season data indicates that approximately 60% of Fraser River pink salmon migrated through Johnstone Strait in 2001. This estimate was based on purse seine test fishing estimates of abundance and was much higher than the long-term average diversion rate of 38% (1959-99). The 50% migration date (Area 20 timing) was September 2, the same as forecast, but five days later than average.

The pattern of daily pink salmon escapements in the Fraser River, measured by Cottonwood test fishing CPUE (lagged two days from Mission) and Duncan Bar CPUE data is shown in Figure 9. The extreme near-shore migration of pink salmon that was identified in 2001 precluded reliable estimates being obtained from the Mission hydroacoustic program. Both Cottonwood and Duncan Bar CPUE data indicated that 50% of the migration had passed Mission by September 12. This was one of the earliest upstream migration dates on record and was seven days earlier than average (September 19). Whereas the migration timing through Juan de Fuca and Johnstone Straits were approximately five days late, the upstream migration at Mission was estimated to be seven days early. Given normal travel rates between areas, the delay of Fraser River pink salmon in the Strait of Georgia was estimated to be only one to two days. This was the shortest period of delay on record and suggested similarities with Late-run sockeye in their migratory behaviour in this area.

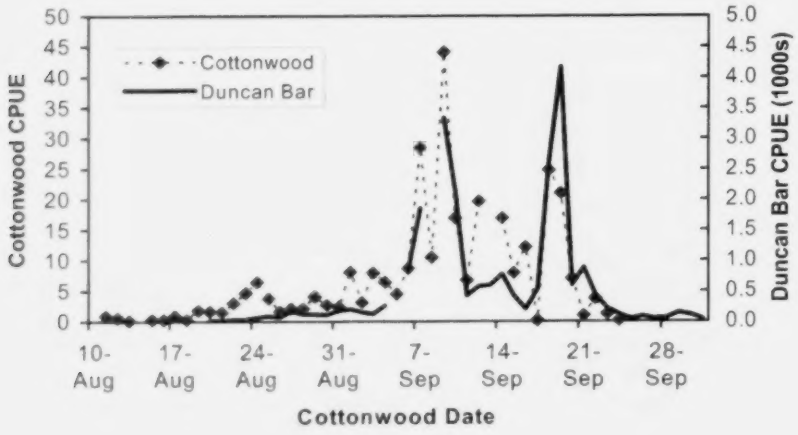

Figure 9. Daily CPUE data for pink salmon in the Cottonwood gillnet test fishery and in DFO's beach seine fishery at Duncan Bar the same day.

C. Split-Beam Hydroacoustic Study at Mission

PSC and DFO staff conducted a joint split-beam hydroacoustic study[3] from 1995-1998 to examine assumptions regarding salmon behaviour and distribution that are implicit in the standard echosounding method. The standard program employs a single-beam acoustic sampling system (mobile and stationary sounding from a vessel) and a duration-in-beam model to estimate the daily escapement of sockeye past Mission. The split-beam program employed side-looking transducers mounted in near-shore areas. The split-beam technology offers several advantages over the single-beam system including the provision of direct measurements of fish speed, travel direction and acoustic size (target strength).

In 1999 the PSC/DFO split-beam hydroacoustic team shifted from evaluating the single-beam echosounding system to feasibility studies on applying split-beam sonar technology for estimating the migration of sockeye past Mission. These studies continued in 2001 and utilized the following split-beam sonar configurations:

1. a near-shore, side-looking system on the south shore using two narrow-beam transducers;
2. a near-shore, side-looking system on the north shore using one narrow-beam transducer; and
3. a downward-looking, 30-degree circular transducer system operated on the vessel along with the single-beam system.

The main objective of these studies was to test the effectiveness of operating an integrated split-beam system with near real-time processing of acoustic data that could provide daily escapement estimation of sockeye salmon. Data obtained from the near-shore, side-looking systems indicated that salmon (mainly sockeye) exhibited normal upstream migratory behaviour in 2001 in terms of their cross-river distribution and speed and direction of travel, similar to that observed in 1995, 1999 and 2000. Analysis of the 2001 split-beam transecting data indicated that a 30-degree wide beam is unlikely to be suitable for measuring fish speed because an inherent target-positioning bias tends to produce underestimates of fish speed. A multi-beam sonar system was also deployed from the PSC echosounding vessel during early August to monitor the response of fish to the vessel. Preliminary analysis of these multi-beam data indicated that fish reacted to the vessel, including when the vessel was anchored and the engine off. The near-shore, side-looking systems indicated that the migration patterns of pink salmon were generally clustered and near the shore, which was consistent with previous observations. Additional developmental work will be required before split-beam hydroacoustic estimation of salmon passage replaces the single-beam methodology.

VII. RACIAL IDENTIFICATION

A. Sockeye Salmon

PSC staff conduct programs designed to identify the stock proportions of Fraser River sockeye in commercial, test and First Nations' catches. These data provide information on the abundance and timing of sockeye stocks as they migrate to their natal rivers in the Fraser River watershed. Racial data are also used to account for Fraser River sockeye salmon wherever they may be caught, and to apportion the daily estimates of sockeye escapement past Mission into discrete stock groups.

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[3] Xie, Y., G. Cronkite and T.J. Mulligan. 1997. A split-beam echosounder perspective on migratory salmon in the Fraser River: A progress report on the split-beam experiment at Mission, B.C., in 1995. Pacific Salmon Comm. Tech. Rep. No. 8: 32 p.

Racial analysis methods in 2001 were similar to past years except that tissue samples for DNA analysis were collected regularly from marine, river, and test fisheries. While scale-based analyses formed the basis of the racial analysis, the DNA data were analyzed in-season for near real-time comparisons. In addition, parasite analyses were conducted as in recent past years[4,5].

Analyses of scale samples from catches in commercial and test fisheries were conducted daily, beginning in late June and continuing through mid-September. Commission staff sampled test fishing catches and commercial sockeye landings at sites in Vancouver, Steveston, Port Renfrew, and Port Hardy, British Columbia and Bellingham and Blaine, Washington. The Alaska Department of Fish and Game (ADF&G) collected samples from the District 104 purse seine fishery at landing sites in Petersburg and Ketchikan, Alaska. DFO provided samples from Johnstone Strait purse seine test fisheries. In addition, the PSC requested that DFO and First Nations' personnel coordinate weekly scale sampling of Fraser River First Nations' fisheries from six regions along the Fraser River between Chilliwack and Prince George. While regular samples were obtained from two sites (Lytton and Bridge River), very few samples were obtained at the remaining four sites (Chilliwack, Yale, Sheep Creek and Prince George).

Tissue samples for DNA analysis were collected from 100 fish, three times per week from test fishing catches at Whonnock and once per week from test fisheries in Areas 12, 13 and 20. The collection of scale, tissue and parasite samples from the same fish allowed comparison of the different racial analysis methods.

i. Analyses

In 2001, the pre-season forecasts of the most abundant stocks and/or stock groups were Quesnel, Chilko, and Late Stuart. These stocks, along with less abundant stocks, were combined to form seven stock groups: Early Stuart, Fennell/Bowron/Chilliwack, Nadina/Gates/Pitt, Chilko/Quesnel, Late Stuart/Stellako, Birkenhead/Adams/Cultus, and Weaver/Portage/Harrison. For most stock identification analyses in 2001, the seven stock groups were incorporated into one of two categories of in-season models: (1) those with Early Summer-run and Summer-run stock complexes, or (2) those with Summer-run and Late-run stock complexes.

Stock-specific baseline standards used for in-season racial analyses were developed from two sources. The preferred source relied on scales from previous year age 3 and age 4 siblings of current year age 4 and age 5 fish because they have reared together in the same nursery lake and thus have similar freshwater scale patterns. A second, less preferable source was used when sibling data from the previous year are unavailable. In this method, baseline standards are developed using data from the same age class but from prior years. Because of the low return of age 3 fish in 2000, only the Gates Creek stock provided sufficient returns of jacks for scale samples (n=91) to develop age 4 standards. Although small samples from jacks were also available for Chilko (n=8), and Quesnel stocks (n=33), the majority of scales for age 4 standards for these stocks and other stocks came from prior years' age 4 returns. The reliance on standards created from past years' age 4 scales reduces the accuracy of in-season baseline standards compared to years when sufficient jack samples are available for baseline standards.

Discriminant Function Analysis (DFA) of scale patterns from standards that were developed pre-season, identified similarities within the following groups: (1) Chilko/Quesnel and Fennell/Bowron/Chilliwack; and (2) Stuart/Stellako, Nadina/Pitt, Birkenhead/Adams/Cultus and Weaver/Portage. These similarities in the scale patterns caused the most difficulty for stock discrimination models during periods when the timing of the less abundant Early Summer-run and Late-run stocks overlapped considerably with the more abundant Summer-run stocks (Figure 4). The timing and abundance overlaps were usually divided into two distinct periods: (1) the transition from Early Summer-run to Summer-run sockeye, and (2) the transition from Summer-

[4] Gable, J.H. and S.F. Cox-Rogers. 1993. Stock identification of Fraser River sockeye salmon: methodology and management application. Pacific Salmon Comm. Tech. Rep. No. 5: 36 p.

[5] Pacific Salmon Commission. 1999. Report of the Fraser River Panel to the Pacific Salmon Commission on the 1997 Fraser River sockeye and pink salmon fishing season. Vancouver, B.C., 47 p.

run to Late-run sockeye. However, in 2001, difficulties in stock identification were exacerbated by the extremely early upstream migration of Late-run stocks combined with weaker than forecast returns of Summer-run sockeye and strong returns of Early Summer-run age 5 fish. Consequently, depending on the area, Early Summer-run, Summer-run and Late-run sockeye were all present in samples collected from both river and marine areas for a two week period from late July to mid-August. When stocks with similar scale characters differ greatly in abundance in mixtures, stock discrimination models tend to overestimate stocks present in low proportions and underestimate stocks present in high proportions. The methods used to minimize this bias were similar to past years[6]. However in 2001, the scale analyses were compared in-season to results from DNA and parasite analyses. General agreement in the results from these three independent analyses indicated that the scale-based analyses provided consistent and reasonable in-season estimates of stock proportions.

Post-season racial analyses were performed using baseline standards derived from spawning ground scale samples collected in 2001. The major stocks included in each stock group were the same in the in-season and post-season DFA models.

ii. Microsatellite DNA Program Update

In 2001, PSC staff continued their collaboration with DFO to assess the potential use of microsatellite DNA markers to distinguish among Fraser River sockeye stocks. The results from analyses of baseline samples and mixture samples collected by PSC staff with assistance from DFO in 2000 and 2001 were encouraging. In both years, DNA-based estimates of stock abundances migrating past Mission were very similar to post-season scale-based estimates. These results suggest that the DNA method will help overcome the main problems in the scale-based method in recent years, i.e., interannual variability in scale patterns combined with the lack of jacks for sibling scale samples. In addition to these analyses, PSC staff collected spawning ground samples from 21 Fraser River sockeye populations in 2001 to expand the DNA baseline. Early Summer-run and Summer-run stocks (especially Quesnel sub-stocks) were the focus of spawning ground sampling in 2001 to improve representation of these stocks in the baseline. In addition, three spatial (area) and temporal (timing) replicate samples were obtained from the Horsefly River. These samples will help in assessments of the variation within stocks of the DNA markers.

Plans for the DNA program in 2002 include the analysis of two additional major histocompatability (mhc) loci to improve the stock discrimination capability (bringing the total to 16 loci). Simulation work will be conducted to: (1) determine required mixture sample sizes to achieve required accuracy levels given different combinations of stocks in the mixtures; and (2) determine if specific loci can be removed from the baseline to reduce the cost of DNA analyses without significantly decreasing accuracy. Near real-time analysis of microsatellite DNA is expected to provide improved accuracy and reliability in the sockeye racial analysis program and provide a powerful tool for the identification of individual fish to stock of origin.

iii. Estimates of Escapement and Production by Stock Group

Estimates of gross escapement (Mission escapement plus First Nations' catch below Mission) by stock group (Table 11) based on in-season racial data, were compared to estimates where post-season racial standards were applied. This enabled PSC staff to determine the effect of changes between in-season and post-season estimates of racial composition. The post-season racial estimates were within 20% of the in-season estimates for all stock groups except the Nadina/Gates/Pitt group. Post-season estimates for this stock group were 52% larger that in-season estimates principally because of in-season difficulties in estimating the Upper River Pitt stock proportions. As those fish migrate out of the Fraser mainstem downstream of Mission, errors in the Pitt racial analysis did not affect the Mission estimates.

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[6] Pacific Salmon Commission. 2000. Report of the Fraser River Panel to the Pacific Salmon Commission on the 1998 Fraser River Sockeye fishing season. Vancouver. B.C., 66 p.

Table 11. Comparison of hydroacoustic-based gross escapement estimates for Fraser River sockeye salmon stocks in 2001, using in-season versus post-season stock composition estimates.

Run	Gross Escapement *		Difference	
	In-season	Post-season	Fish	%
Early Stuart	221,000	243,000	22,000	10%
Early Summer				
Sco/Sey/Bow/Fen/Chilw	67,000	76,000	9,000	13%
Nadi./Raft/Gates/Pitt	226,000	343,000 **	117,000	52%
Total	293,000	419,000	126,000	43%
Summer				
Chilko/Quesnel	3,616,000	3,719,000	103,000	3%
L.Stuart/Stellako	725,000	598,000	(127,000)	-18%
Total	4,341,000	4,317,000	(24,000)	-1%
Late				
Birk., Adams, Cultus	123,000	134,000	11,000	9%
Weaver, Portage	273,000	241,000	(32,000)	
Harrison, Wigeon	89,000	79,000	(10,000)	-11%
Total	485,000	454,000	(31,000)	-6%
Total	5,340,000	5,433,000	93,000	2%

* Escapement past Mission plus Aboriginal catches below Mission.

** Includes actual upper Pitt River spawning escapement estimate.

The return of Early Stuart sockeye (214,000 fish, Table 12) was approximately half of the pre-season 50% probability level forecast (420,000 fish). However, the age 4 return of Early Stuart sockeye was only about 25% of the 50% probability level forecast. The recruitment rate for age 4 fish was only 0.4 fish per brood year spawner, the lowest on record. Recorded catches for this stock consisted of 5,000 fish in test and miscellaneous non-commercial fisheries and 38,000 fish in Fraser River First Nations' fisheries. The exploitation rate on Early Stuart sockeye for all catch areas was 20%. The upstream estimates of Early Stuart migration (catch plus spawning escapement) were 33,000 fish lower than the Mission hydroacoustic estimates.

The return of Early Summer-run stocks was estimated at 393,000 fish (Table 12), which was nearly double the pre-season 50% probability level forecast of 202,000 fish due to a much larger return of age 5 fish than expected. The age 4 return was approximately 52% of the forecast. Recruitment rates for age 4 sockeye returning to spawning areas upstream of the Fraser Canyon were only 1.15 fish/spawner. Catches of Early Summer-run sockeye from commercial, test, and marine First Nations' fisheries totalled 20,000 fish. In addition, Fraser River First Nations and in-river recreational fisheries harvested 71,000 fish. The exploitation rate on Early Summer-run stocks was 23%. The upstream estimates of Early Summer-run migration (catch plus spawning escapement) were 46,000 fish less than the Mission hydroacoustic estimates.

The adult production of Summer-run stocks was 6,043,000 fish (Table 12), which was about half the pre-season 50% probability level forecast (11,715,000 fish) but near the 75% probability level forecast (6,159,000 fish). This resulted from lower than expected age 4 returns. The average age 4 recruitment rate for Summer-run stocks was 1.45 fish per brood year spawner, but Late Stuart (0.39) Stellako (1.25) and Chilko (0.67) recruitment rates were lower. Survival of Chilko smolts to age 4 adults was estimated at 3.0% compared to the long-term average of 9.6%. Commercial, test and marine First Nations' catches totalled 792,000 fish, while Fraser River First Nations' and in-river recreational catches totalled 568,000 fish. The exploitation rate for Summer-run stocks in all fisheries was 23%. The upstream estimates of Summer-run migration (catch plus spawning escapement) exceeded estimates based on the Mission hydroacoustic program by 934,000 fish. Production of Quesnel (4,382,000 fish), Chilko (852,000), Late Stuart (564,000) and Stellako (245,000) sockeye stocks were all close to the 75% probability level forecasts.

Table 12. Catches, escapements, differences between estimates, run sizes and exploitation rates for Fraser River sockeye (by stock group) and pink salmon in 2001.

Stock Group	River & Ocean Catch *	Gross Escapement: In-river Indian & Sport Catch	Gross Escapement: Spawning Escapement	Gross Escapement: Difference** Between Estimates	Run Size: Adult	Run Size: Jacks	Portion of Run	Adult Exploitation Rate: River & Ocean	Adult Exploitation Rate: All Areas
Sockeye Salmon									
Early Stuart	5,000	38,000	171,000	0	214,000	0	3%	2%	20%
Early Summer-run									
Sco/Sey/Bow/Fen/Chlw	6,000	5,000	62,000	0	73,000	1,000	1%	8%	15%
Nadi./Raft/Gates/Pitt	14,000	66,000	240,000	0	320,000	0	4%	4%	25%
Total	20,000	71,000	302,000	0	393,000	1,000	5%	5%	23%
Summer-run									
Chilko/Quesnel	602,000	452,000	4,180,000	0	5,234,000	1,000	73%	12%	20%
L.Stuart/Stellako	190,000	116,000	503,000	0	809,000	0	11%	23%	38%
Total	792,000	568,000	4,683,000	0	6,043,000	1,000	84%	13%	23%
Late-run									
Birk., Adams, Cultus	32,000	8,000	49,000	77,000	166,000	19,000	3%	19%	24%
Weaver, Portage	44,000	9,000	36,000	196,000	285,000	0	4%	15%	19%
Harrison, Wigeon	11,000	6,000	15,000	58,000	90,000	0	1%	12%	19%
Total	87,000	23,000	100,000	331,000	541,000	19,000	8%	16%	20%
Total Adults	904,000	700,000	5,256,000	331,000	7,191,000	21,000	100%	13%	22%
Total Jacks	0	0	21,000	0	21,000				
Total	904,000	700,000	5,277,000	331,000	7,212,000				
Portion of Total Run	13%	10%	73%	5%	100%				
Pink Salmon									
Total	1,316,000	134,000	19,843,000	-	21,293,000			6%	7%
Portion of Total Run	6%	1%	93%	-	100%				

* Includes catches in all fisheries, excluding Fraser River Aboriginal and recreational fisheries above Mission.

** Differences between gross escapement estimates are the lower river estimates (Mission + IF catch, PSC) minus the up-river estimates (spawning escapement + IF catch + sport catch + ESSR catch, DFO).

The adult return of 541,000 Late-run sockeye (Table 12) was slightly higher than the pre-season 50% probability level forecast (528,000 fish). However, the age 4 return was only 56% of the forecast estimate. Catches of Late-run sockeye in commercial test and marine First Nations' fisheries totalled 87,000 fish. Catches in Fraser River First Nation's and in-river recreational fisheries totalled 23,000 fish. The exploitation rate on all Late-run stocks combined was 20%. However, the exploitation rate on true Late-run stocks was estimated at 19% (Table 12). En route mortalities were estimated at 331,000 fish. Weaver sockeye dominated the Late-run production with a return of 225,000 fish. The remainder of Late-run production was in from Adams/Lower Shuswap (122,000), Harrison River (90,000), Portage Creek (43,000) and Birkenhead (63,000) sockeye. Age 4 recruitment rates for Late-run sockeye stocks (3.1 fish per brood year spawner) were below average but higher than earlier-timed stocks.

The total return of adult Fraser River sockeye in 2001 was estimated to be 7,191,000 fish (Table 12). Catches in all fisheries accounted for 22% of the return while 78% of the fish were available for spawning escapement. However, estimated spawning escapements totalled 5,256,000 adults, or 73% of the total return. The remaining 5% of the fish were Late-run sockeye that were not accounted for in upstream catch and escapement. This was likely due to en route mortalities associated with their early upstream migration timing and subsequent vulnerability to the parasite, *Parvicapsula*. Of the harvest component (22%) of the return, commercial fisheries harvested 8%, miscellaneous non-commercial fisheries (including test fisheries) harvested 2%, marine First Nations' fisheries took 3% and Fraser River First Nations' fisheries accounted for approximately 9% (Table 4).

In total, the recruitment of age 4 sockeye was 1.40 fish per brood year adult spawner. This was one of the lowest rates of recruitment on record for Fraser sockeye.

B. Pink Salmon

Catches of Fraser River pink salmon harvested in mixed stock fisheries have been estimated using GSI (genetic stock identification) techniques since 1987. The GSI program relies on genetic differences among stocks of pink salmon, expressed as different enzyme phenotypes in their body tissues. Pink salmon that spawn in Washington and British Columbia have been sampled and their tissues (muscle, heart, liver, and eye) electrophoretically analyzed. These genetic data have been compiled into baselines that profile the genetic characteristics of each pink salmon stock. During the in-season management period, muscle tissue samples from approximately 150 pink salmon were collected weekly from fisheries of interest. After electrophoretic screening of the tissue samples, the results were analyzed using a maximum likelihood (MLE) model. The model compares known genetic standards (from baseline samples) to genetic data from samples of unknown stock composition (from in-season, mixed-stock fishery samples) and generates estimates of the most likely stock composition.

In 2001, as in 1999, there were few large-scale commercial fisheries directed at Fraser River pink salmon. Consequently, only a small number of samples were collected for GSI. The primary uses of the GSI estimates of stock contributions in 2001 were catch allocation, migrational analyses, and run-size estimation. GSI samples were collected in Canadian statistical Areas 12, 13, and 20, United States Areas 7 and 7A from early August to early September.

The contribution of Fraser pink salmon in the GSI samples collected from Area 12 commercial test purse seine catches increased from approximately 32% in early August to 89 % by early September. GSI samples were also collected from Area 20 purse seine catches over the same period as in Area 12 and showed contributions of Fraser pink salmon increasing from 73% to 84%. In United States Areas 7 and 7A, Fraser pinks comprised only 21% of the catch at the beginning of August, but dominated the catches by early September (91%). The pattern of high Fraser pink contributions relative to other co-migrating stocks from Puget Sound and Canada non-Fraser stocks was generally consistent with that indicated by the GSI analyses from prior years. Catches of Fraser River pink salmon totalled 1,450,000 fish in all fisheries, which included 134,000 from First Nations fisheries, and 38,000 from test fisheries. The harvest rate on Fraser River pink salmon in 2001 was 7%, which is approximately one-tenth of the average harvest rate on Fraser River pink salmon since 1959. Although the total catch of Fraser pinks in 2001 was much larger than in 1999, the catch was only 20% of the average catch from the period 1989-1997. DFO's near-final estimate of spawning escapement estimate is 19,843,000 fish, which is the largest on record.

VIII. ESCAPEMENT

The enumeration of sockeye and pink salmon escapements in the Fraser River watershed (Figure 10) is conducted annually by DFO. Data collected in the program are used to generate estimates of the total production of sockeye on a stock and run-timing group basis and total production of pink salmon. The Fraser River Panel also relies on the spawning ground escapement estimates to determine if the goals have been met, which is the highest priority objective of the Panel's in-season management. Further, the escapement estimates provided by DFO help in the post-season evaluation of stock identification and stock monitoring programs conducted by PSC staff. Samples of scales, otoliths, and tissues and length measurement data are collected by DFO staff for processing by PSC staff and provide much of the data used in post-season analyses.

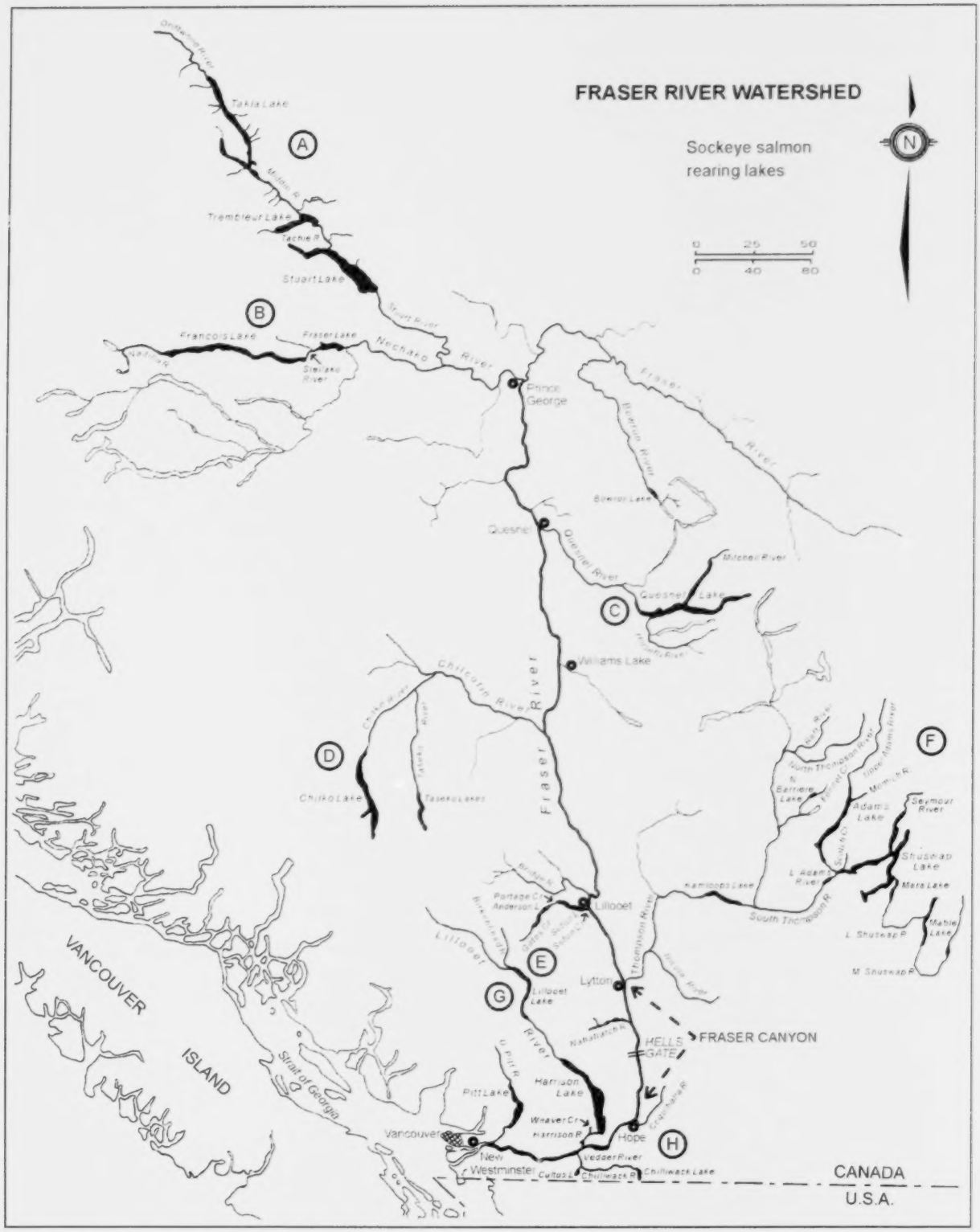

Figure 10. Sockeye salmon spawning grounds in the Fraser River watershed.

Sockeye Salmon

In 2001, the preliminary estimate of adult sockeye (primarily age 4 and age 5 fish) escapement was 5,257,000 fish (Appendix H, Table 13). The 2001 escapement was 1,005,000 fish (24%) larger than estimated in the brood year (1997) and was the third highest since 1938. The escapement of 22,000 jack sockeye (age 3 fish) was over twice the brood year level and similar to the number estimated in 1993. The Early Stuart escapement of 171,000 sockeye (Table 13) was (36%) lower than the brood year (1997) when the escapement was 266,000 fish. Escapements of Early Summer-run stocks increased to 302,000 fish, which was a record for the cycle and four times higher than the 1997 escapement. Summer-run escapements were 23% higher than 1997, and 4,683,000 sockeye arrived at their spawning grounds. Approximately 100,000 Late-run sockeye arrived at their spawning grounds in 2001, which was 12% higher than the brood year. The primary cause of the large escapement of Summer-run sockeye and the slight increase in Late-run stocks was the tightly constrained harvest policy on Late-run stocks. The exploitation rate on Summer-run and Late-run sockeye was only 23% and 20%, respectively.

Table 13. Adult sockeye salmon escapements by run-timing group on the 2001 cycle for years 1985-2001.

	Spawning Escapement				
Run	1985	1989	1993	1997	2001
Early Stuart	235,000	385,000	688,000	266,000	171,000
Early Summer	46,000	63,000	86,000	89,000	302,000
Summer	1,738,000	2,553,000	5,072,000	3,807,000	4,683,000
Late	59,000	59,000	356,000	90,000	100,000
Adults	2,078,000	3,060,000	6,202,000	4,252,000	5,256,000

The distribution of the 171,000 Early Stuart sockeye that reached their spawning areas in 2001 was: 78,000 fish to tributaries of Takla Lake (46%), 39,000 fish to the Middle River (23%) and 38,000 fish to tributaries of Trembleur Lake (22%) (A; Figure 10). The Driftwood River, which flows into the north end of Takla Lake, was the destination of 16,000 fish or approximately 9% of the Early Stuart run. The proportion of the Early Stuart escapement reaching the Driftwood River was low in 2001 as occurred in 1997 (11%). The Driftwood system normally contributes from 40% to 60% of the total Early Stuart sockeye production on this cycle. Adverse migration conditions (high water levels) in the Fraser River in 1997 when Driftwood River sockeye were returning to their spawning grounds led to the extremely poor escapement. While the escapement of 171,000 Early Stuart sockeye in 2001 was only 64% of the brood year, the high proportion of females and a high spawning success (93%) gave a larger effective (successful spawning) female spawning population in 2001 than in 1997. Only 46% of the total run of Early Stuart sockeye (214,000 fish) in 2001 were age 4 sockeye, with the remainder being age 5 fish. Normally, close to 100% of Early Stuart sockeye on the dominant line are age 4 fish.

The escapement of 352,000 Late Stuart sockeye was only 39% of the brood year escapement (908,000 fish). The largest declines were observed at Kuzkwa Creek and Tachie River, where only 15% and 38% of the brood year escapements levels, respectively, were estimated in 2001. Although spawning of Late Stuart sockeye was much lower than the brood year, the spawning success was high (96%). As in the Early Stuart escapement, a very high proportion of Late Stuart sockeye in 2001 were age 5 fish (38%) whereas normally nearly 100% are age 4 on the dominant line.

The Nadina River (Nechako River watershed, B; Figure 10) and spawning channel combined escapement totalled 55,000 sockeye, the third largest on record and about six times the brood escapement. This large escapement was primarily age 5 fish (97%) from the very successful 1996 brood spawning, which provided 200,000 escapement of age 4 fish in 2000. The escapement of

Summer-run sockeye to the Stellako River was 151,000 fish, which was almost three times the brood year escapement. The 2001 cycle has been a lower production line for Stellako River, thus the 2001 escapement was the largest recorded for this line. Approximately 72% of Stellako sockeye were age 5 fish.

Spawning escapements to the Bowron River increased slightly, from 4,800 fish in 1997 to 5,800 fish in 2001. The 2,900 female spawners had a spawning success rate of 94%. Over 80% of Bowron River spawners were age 5 sockeye.

Escapement of 3,511,000 sockeye to the Quesnel watershed (C; Figure 10) was nearly double the brood year spawning of 1,859,000 fish in 1997. Spawning in the Horsefly River system accounted for 2,084,000 fish, which included 267,000 sockeye in McKinley Creek. The Mitchell River escapement of 920,000 sockeye was 72% higher than the brood year. Over 500,000 fish were estimated spawning along Quesnel Lake beaches and in small tributaries to the lake. Quesnel spawners were over 99% age 4 fish, which is normal for the dominant cycle line. The overall spawning success of Quesnel sockeye averaged 91%.

Chilko River and Lake escapements (D; Figure 10) declined 32% from the brood year to 669,000 sockeye in 2001. However, the 2001 escapement is the third consecutive large escapement on this cycle line (compared to an escapement of 63,000 fish in 1989). The spawning success of female Chilko spawners in 2001 was estimated at 98%.

Early Summer-run escapements to Gates Creek and channel in the Seton-Anderson system (E; Figure 10) increased from about 6,500 fish in the brood year to 13,000 fish in 2001, although this was slightly lower than the escapements on this line in 1989 and 1993. Spawning success was low in both the creek and spawning channel and averaged only 49%. The return of Late-run sockeye to Portage Creek dropped from 9,800 fish in the brood year to 3,200 fish in 2001, which was partially due to en route mortality experienced by Late-run stocks associated with early upstream migration. The spawning success of females that reached the spawning ground was 90%.

Sockeye stocks in the Thompson River watershed spawn in the North Thompson and South Thompson River systems (F; Figure 10). In the South Thompson, the Early Summer-run escapement of 6,900 sockeye to the Seymour River and tributaries was approximately three times the brood year. The return of 2,400 spawners to Scotch Creek was slightly lower than the brood year. Spawning success in these two streams was excellent (95-100%). In addition, 3,700 adult Early Summer-run sockeye returned to spawn in other South Thompson tributaries, including 600 to the Upper Adams River. Most of these (97%) were age 5 fish from the very successful 1996 brood that produced a record escapement in 2000.

Late-run stocks in the South Thompson system are dominant on the 2002 line and, thus, the majority of spawners on the 2001 line are normally age 3 jacks of the dominant line (1998) spawning. The escapement of 15,000 jack sockeye to the Lower Adams and Lower Shuswap Rivers was much larger than the return in 1997 (300 fish) and over 50% higher than the return in 1993. Adult spawning escapements were also higher in 2001, although very small numbers survived to spawn. A high proportion of adult Adams River sockeye were estimated to have died en route to their spawning grounds in 2001, which is likely associated with their very early river entry.

Good returns (7,500 fish) of Early Summer-run sockeye were observed in the North Thompson River, which normally is a very small stock. Raft River had an escapement of 32,000 fish, which was over five times the brood year spawning of 6,100 fish and the third highest of all years of record. About 92% of the female population spawned successfully. The Fennell Creek spawners (5,700 fish) achieved a spawning success rate of 97%.

The individual spawning population levels of Late-run sockeye observed in the Harrison-Lillooet area (G; Figure 10) ranged from substantially higher to lower than the brood year, while the total was 17% higher. The 44,000 sockeye escaping to the Birkenhead River represented a decline of 11% from the brood year although spawning success was high (98%). Big Silver Creek (tributary of Harrison Lake) had an escapement of 11,000 sockeye, which was over seven times

the brood year level. Approximately 83% of Big Silver sockeye were age 5 fish. Harrison River sockeye also had a very large escapement in 2001 (15,000 sockeye) and spawning success was estimated at nearly 100%. Approximately 20,000 sockeye returned to Weaver Creek and spawning channel, which was 22% lower than the brood year escapement. The spawning success of the 4,200 adults that spawned in Weaver Creek sockeye was very low (8%) but the 16,000 fish in the spawning channel had much higher success (81%).

Returns of Early Summer-run sockeye to Lower Fraser River tributaries (H, Figure 10) were generally very high in 2001. A counting tower was erected at the outlet of Chilliwack Lake to estimate the escapement into that system. The migration of sockeye into Chilliwack Lake for spawning in the lake and the Upper Chilliwack River was estimated to be 30,000 sockeye, which is the largest escapement on record. Limited access by enumerators to the primary spawning area (Upper Chilliwack River) in the past may have resulted in under-estimates of escapement. Although the escapement of 5,400 Nahatlatch sockeye was below the brood year escapement, it was higher than the average return from recent years on this cycle. Spawning success was high in the Nahatlatch River (97%) but low in Nahatlatch Lake (47%). The escapement of Upper Pitt River sockeye on this cycle has increased consistently since 1985, culminating in a record 131,000 fish in 2001, which was almost four times the brood year escapement and the largest on record. Approximately 91% of Upper Pitt sockeye were age 5 fish, a relatively high proportion, however, the Pitt stock typically has a high proportion of age 5 fish. Spawning success of these fish was estimated at 99%. The escapement of 500 Late-run sockeye to Cultus Lake was much higher than in 1997 and similar to the return in 1989. However, spawning success of these fish was very low, similar to observations in other recent years of very early upstream migration.

The overall spawning success of adult female sockeye salmon in the Fraser River watershed in 2001 was 92.5%, which was slightly higher than observed in 1997 (89.4%). The effective female spawning population in 2001 was 2,807,000 sockeye (approximately 29% higher than the brood year).

B. Pink Salmon

Fisheries and Oceans Canada's near-final estimate of Fraser River pink salmon escapement in 2001 is 19,843,000 fish. This was 53% larger than the largest recorded escapement (since 1959) of 12,943,000 fish (1991). The marine survival rate of Fraser River pink salmon returning in 2001 from the 1999 brood year escapement was 9.6% (Appendix H, Table 14). This is approximately three times the average marine survival rate and over 50% higher than the previous record marine survival rate.

IX. ACHIEVEMENT OF OBJECTIVES

The mandate of the Fraser River Panel is to manage commercial fisheries in Panel Area waters to achieve a hierarchy of annual goals. In order of importance, these goals are to: (a) achieve escapement targets for Fraser River sockeye and pink salmon that are set by Canada or modified by Panel agreement; (b) achieve targets for international sharing of the TAC as defined in the Treaty or by agreement of the Parties; and (c) achieve domestic catch allocation goals within each country. The first objective, to achieve escapement targets, was modified in 2001 to the extent that the Panel agreed (June 28, 2001, Appendix B) to a maximum 60% harvest rate on Summer-run sockeye and a maximum 17% harvest rate true Late-run sockeye. These limits replaced the standard spawning escapement targets set by Canada in previous years (see "Gross Escapement" section below). In the process of achieving the objectives listed above, the Panel must consider the conservation concerns for other stocks and species of salmon when planning and conducting the fisheries. Panel management strategies are assessed after each season to determine whether the goals were met and to improve management techniques and data collection programs.

A. Gross Escapement

The Panel's first task is to achieve Canada's gross escapement targets by run timing group (Early Stuart, Early Summer-run, Summer-run and Late-run). Gross escapement targets include fish for spawning and for First Nations and recreational harvest in the Fraser River. A third category, "Management Adjustments", has been added to gross escapement targets in recent years to help ensure spawning escapement targets are reached. Calculation of these adjustments comes from either: (a) bias in the relationship between gross escapement estimates in the lower river (Mission escapement estimate plus Fraser First Nations' catch below Mission) and estimates made upstream (First Nations' catch plus spawning escapement), or (b) in-season predictions of en route or pre-spawning mortality rates. On June 28, 2001, the Panel agreed to a Management Adjustment of 54,000 Early Stuart and 30,000 Early Summer-run fish to compensate for the tendency for in-season gross escapement estimates to be greater than upriver estimates for these run-timing groups. These adjustments to the gross escapement targets were later modified based on actual returns.

A key element in the management of fisheries in 2001 was the agreed 17% exploitation rate limit on true Late-run sockeye. This limit, which was developed due to conservation concerns due to the early in-river migration and associated high en route mortality of Late-run sockeye in recent years, was incorporated into the in-season gross escapement target and resulted in restricted fishing opportunities during the migration of Summer-run and Late-run sockeye through the marine approach areas. As a result, the actual exploitation rate on true Late-run sockeye was 19% (Table 12), or 2% higher than the 17% limit. For Summer-run stocks, the estimated exploitation rate of 23% was much lower than the 60% limit.

The success of Panel management can be assessed by: (a) whether in-season lower-river estimates of gross escapement met the adjusted gross escapement targets; and (b) whether upriver gross escapement estimates met the unadjusted targets. By the first measure (Table 14), the adjusted gross escapement target was not achieved for Early Stuart sockeye (4,000 fish under), exceeded for Early Summer-run (141,000 fish over) and Summer-run stocks (412,000 fish over) and exceeded slightly for Late-run stocks (26,000 fish over). The summed gross escapements exceeded the target by 575,000 fish. Percentage deviations from the targets were as follows: 2% under for Early Stuart, 93% over for Early Summer-run, 10% over for Summer-run and 6% over for Late-run stocks, which resulted in an aggregate deviation of 12%.

By the second measure (Table 15), upriver estimates of gross escapement were above the target for Early Stuart (45,000 fish over), considerably higher than the targets for Early Summer-run (251,000 fish over) and Summer-run sockeye (1,322,000 fish over), and substantially less than the target for Late-run stocks (336,000 under). In total, the upriver estimate of gross escapement

was 1,282,000 fish (27%) more than the in-season target. The shortfall in Late-run escapements was largely due to en route mortality, as discussed in the Introduction section. The overages in the Early Summer-run and Summer-run escapements were partially due to the protective measures that were applied to maximize the escapement of Early Stuart, Early Summer-run, and Late-run fish. Upstream estimates of total gross escapements for these run-timing groups exceed the in-season estimates.

Table 14. Comparison of in-season adjusted targets and in-season lower-river gross escapement estimates for Fraser River sockeye salmon in 2001.

	Gross Escapement				
Run	In-season Target	Management Adjustment*	Adjusted Target	In-season Estimate**	Difference
Early Stuart	164,000	61,000	225,000	221,000	(4,000)
Early Summer	122,000	30,000	152,000	293,000	141,000
Summer	3,929,000	0	3,929,000	4,341,000	412,000
Late ***	459,000	0	459,000	485,000	26,000
Adults	4,674,000	91,000	4,765,000	5,340,000	575,000

* Panel-agreed adjustment of gross escapement targets to achieve spawning escapement goals.

** Includes 182,000 sockeye caught in Fraser River First Nations' fisheries below Mission, B.C.

*** Late-run target accounts for exploitation rate limit of 17% for true Late-run stocks.

Table 15. Comparison of in-season unadjusted targets and upriver gross escapement estimates for Fraser River sockeye salmon (adults) in 2001.

	Gross Escapement		
Run	In-season Target	Upriver Estimate*	Difference
Early Stuart	164,000	209,000	45,000
Early Summer	122,000	373,000	251,000
Summer	3,929,000	5,251,000	1,322,000
Late **	459,000	123,000	(336,000)
Adults	4,674,000	5,956,000	1,282,000

* Reported spawning escapements plus Fraser River First Nations and recreational fishery catches, and excluding differences between estimates.

** Late-run target accounts for exploitation rate limit of 17% for true Late-run stocks.

The gross escapement target for Fraser River pink salmon (4,843,000 fish) increased during the fishing season to 6,185,000 fish as run size estimates were larger than the pre-season forecast. The actual gross escapement of 19,977,000 fish was more than three times the in-season target. This large escapement resulted from a combination of conservation actions taken for Late-run sockeye and other species, low effort in commercial fisheries and a much larger than forecast run size.

B. International Allocation

The Panel's second priority is to achieve the goals for international allocation of the TAC, which is based on in-season estimates of run abundance. The final estimate of Washington catch was 241,000 sockeye (Table 16). Canadian fishers caught 797,000 sockeye (73.7% of the TAC) excluding the Fraser River Aboriginal exemption of 400,000 sockeye. The Agreement reached by the Commission on June 28, 2001, (Appendix B) stated that the United States share would not be adjusted post-season as a consequence of Canadian domestic policies that resulted in Canada not

achieving their 81.6% share. Under this provision, the Commission agreed on June 11-12, 2002, that the United States catch in 2001 would constitute the actual share.

With respect to Fraser River pink salmon (Table 16), the final estimate of Washington catch was 445,000 fish (31.5%). Canadian catches totalled 967,000 Fraser pink salmon (68.5% of the TAC). As stated in the June 28, 2001 agreement, each country's allocation was equal to its actual catch.

Table 16. Preliminary calculations of total allowable catch and international shares of Fraser River sockeye and pink salmon in 2001.

	Sockeye	Pink
TOTAL ALLOWABLE CATCH		
Total Run Size	7,213,000	21,293,000
Deductions		
Spawning Escapement	5,278,000	19,843,000
Difference Between Estimates	331,000	-
Fraser River Aboriginal Fishery Exemption	400,000	-
Test Fishing	123,000	38,000
Total Deductions:	6,132,000	19,881,000
Total Allowable Catch:	1,081,000	1,412,000
UNITED STATES		
Washington Catch	241,000	445,000
Washington Share		
Total Share:	241,000 *	445,000 **
Deviation:	0	0
Alaska Catch	43,000	0
Total United States Catch:	284,000	445,000
CANADA		
Canadian Catch - Aboriginal Fishery Exemption	797,000	967,000
Canadian Share	797,000	967,000
Deviation:	0	0

* United States share is the United States catch, in accordance with agreements on June 28, 2001, and June 11-12, 2002.

** United States share is the United States catch, in accordance with agreement drafted January 8, 2002.

C. Domestic Allocation

The third priority of the Panel is to achieve the domestic allocation goals for the Parties. The Panel's ability to achieve such goals is limited because the Panel manages only those fisheries in Panel Areas that are directed at Fraser River sockeye and pink salmon. Canada regulated Canadian net fisheries in non-Panel areas such as Johnstone Strait.

In 2001, allocation goals existed between and within Treaty Indian and Non-Indian user groups in Washington. The allocation of sockeye salmon catch between Treaty Indian and Non-Indian fishers deviated from the goal, with Treaty Indian fishers catching 25,000 fish more than their allocation of 147,000 fish while Non-Indian fishers were 25,000 fish below their allocation of 94,000 fish (Table 17). Within the Treaty Indian group, actual catches deviated from allocations, with fishers in Areas 4B, 5 and 6C catching 16,000 fish more and fishers in Areas 6, 7

and 7A catching 16,000 fish less than the targets. As well, there were modest deviations from the gear allocation targets within the Non-Indian group.

The achievement of domestic allocation goals in Canada (Table 18) was not successful because: (1) there was high uncertainty regarding the potential abundance of Early Summer-run and Summer-run stocks during the early part of the fishing season; and (2) the imposition of severe fishery restrictions due to the anticipated en route mortality of Late-run stocks. Within the Canadian commercial catch of 297,000 Fraser sockeye, Area B purse seines were 52,000 fish under, Area D gillnets were 51,000 fish over, Area E gillnets were 17,000 fish under, Area G trollers were 13,000 fish under and Area H trollers were 31,000 fish over their shares.

Table 17. Preliminary estimates of domestic overages and underages in Washington catches of Fraser River sockeye salmon in 2001.

User Category	Actual Catches		Catch Goals		Overage/ (Underage)
	Fish	%	Fish	%	
Treaty Indians: by Area					
Treaty Indian					
Areas 4B, 5 and 6C	37,000	21.5%	21,000	12.0%	16,000
Areas 6, 7 and 7A	135,000	78.5%	151,000	88.0%	(16,000)
Total:	172,000	100.0%	172,000	100.0%	0
Non-Indians: by Gear					
Purse Seine	40,000	58.0%	38,000	54.0%	2,000
Gillnet	20,000	29.0%	28,000	41.0%	(8,000)
Reefnet	9,000	13.0%	3,000	5.0%	6,000
Total:	69,000	100.0%	69,000	100.0%	0
Washington: between Treaty Indian and Non-Indian Users					
Treaty Indian	172,000	71.4%	147,000	61.0%	25,000
Non-Indian	69,000	28.6%	94,000	39.0%	(25,000)
Washington Total:	241,000	100.0%	241,000	100.0%	0

Table 18. Preliminary estimates of domestic overages and underages in Canadian catches of Fraser River sockeye salmon in 2001.

Gear License Area	Actual Catches		Catch Goals		Overage/ (Underage)
	Fish	%	Fish	%	
Purse Seine					
A Northern	0	0.0%	0	0.0%	0
B Southern	78,000	26.3%	130,000	44.0%	(52,000)
Total	78,000	26.3%	130,000	44.0%	(52,000)
Gillnet					
D Johnstone Strait	94,000	31.6%	43,000	14.5%	51,000
E Fraser River	44,000	14.8%	61,000	20.5%	(17,000)
Total	138,000	46.5%	104,000	35.0%	34,000
Troll					
F Northern	0	0.0%	0	0.0%	0
G Southern	20,000	6.7%	33,000	11.0%	(13,000)
H Inside	61,000	20.5%	30,000	10.0%	31,000
Total	81,000	27.3%	63,000	21.0%	18,000
Total	297,000	100.0%	297,000	100.0%	

Pink salmon catch distribution in United States fisheries deviated substantially from the goal. The Treaty Indian fishery catch was 104,000 fish under while Non-Indian fishers were 104,000 fish over their 50%:50% catch allocation goal (Table 19).

Within Canada, domestic allocation targets were not met. The catch of 757,000 pink salmon was taken primarily in Johnstone Strait by purse seines which resulted in the Area B purse seines being over by 217,000 fish, Area D gillnets under by 23,000 fish, Area E gillnets under by 8,000 fish, Area G trollers under by 151,000 fish and Area H trollers under by 35,000 fish (Table 20).

Table 19. Preliminary estimates of domestic overages and underages in Washington catches of Fraser River pink salmon in 2001.

User Category	Actual Catches		Catch Goals		Overage/ (Underage)
	Fish	%	Fish	%	
Washington: between Treaty Indian and Non-Indian Users					
Treaty Indian	109,000	25.6%	213,000	50.0%	(104,000)
Non-Indian	317,000	74.4%	213,000	50.0%	104,000
Washington Total:	426,000	100.0%	426,000	100.0%	0

Table 20. Preliminary estimates of domestic overages and underages in Canadian catches of Fraser River pink salmon in 2001.

Gear License Area	Actual Catches		Catch Goals		Overage/ (Underage)
	Fish	%	Fish	%	
Purse Seine					
A Northern	0	0.0%	0	0.0%	0
B Southern	671,000	88.6%	454,000	60.0%	217,000
Total	671,000	88.6%	454,000	60.0%	217,000
Gillnet					
D Johnstone Strait	7,000	0.9%	30,000	4.0%	(23,000)
E Fraser River	0	0.0%	8,000	1.0%	(8,000)
Total	7,000	0.9%	38,000	5.0%	(31,000)
Troll					
F Northern	0	0.0%	0	0.0%	0
G Southern	16,000	2.1%	167,000	22.0%	(151,000)
H Inside	63,000	8.3%	98,000	13.0%	(35,000)
Total	79,000	10.4%	265,000	35.0%	(186,000)
Total	757,000	100.0%	757,000	100.0%	

D. Conservation of Other Stocks

Catches of non-target species and stocks in Panel Area fisheries directed at Fraser River sockeye and pink salmon are shown in Table 21. The recorded by-catches totalled 58,900 non-Fraser pink salmon, 1,400 chinook, 2,300 coho, and 100 chum salmon.

Table 21. Preliminary estimates of catches of non-Fraser sockeye and pink salmon and of other salmon species in commercial fisheries regulated by the Fraser River Panel in 2001.

Area and Gear	Non-Fraser		Fraser and Non-Fraser			
	Sockeye	Pink	Chinook	Coho	Chum	Steelhead
United States *						
Areas 4B, 5 and 6C Net	0	1,800	900	2,300	0	0
Areas 6, 7 and 7A Net	0	54,100	400	0	0	0
Total	0	55,900	1,300	2,300	0	0
Canada **						
Area 20 Net	0	3,000	0	0	100	0
Area 29 Net	0	0	100	0	0	0
Total	0	3,000	100	0	100	0
Total	0	58,900	1,400	2,300	100	0

* Estimates are from the WDFW "soft-system".

** Estimates are from DFO in-season hail program.

X. ALLOCATION STATUS

In accordance with the payback policy in the revised (1999) Annex IV of the Treaty, catch overages and underages will be used to adjust United States allocations in subsequent years. After the 2001 fishing season, the United States has a catch overage of 56,000 Fraser sockeye remaining from 2000 and a catch underage of 21,000 pink salmon remaining from 1999 (Table 22).

Table 22. Allocation status of Fraser River sockeye and pink salmon for 1999-2001.

	Sockeye			Pink	
	1999	2000	2001	1999	2001
TOTAL ALLOWABLE CATCH					
Total Run Size	3,644,000	5,217,000	7,213,000	3,616,000	21,293,000
Escapement and other deductions	3,437,000	3,198,000	6,132,000	3,468,000	19,881,000
Total Allowable Catch:	207,000	2,019,000	1,081,000	148,000	1,412,000
UNITED STATES					
Washington Catch	20,000	494,000	241,000	17,000	445,000
Washington Share *	46,000	412,000	241,000	38,000	445,000
Deviation:	(26,000)	82,000	0	(21,000)	0
Cumulative Allocation Status:	(26,000)	56,000	56,000	(21,000)	(21,000)

* Washington share of the TAC according to Annex IV of the Pacific Salmon Treaty:

1999: Shall not exceed 22.4% for Fraser sockeye and 25.7% for Fraser pinks.

2000: Shall not exceed 20.4% for Fraser sockeye.

2001: Washington share equals Washington catch, by agreement between the Parties on June 11-12, 2002.

XI. APPENDICES

APPENDIX A: 2001 PRE-SEASON FORECASTS AND SPAWNING ESCAPEMENT TARGETS FOR FRASER RIVER SOCKEYE AND PINK SALMON

Table 1. Pre-season forecasts for Fraser River sockeye and pink salmon. (Provided to the Panel by Fisheries and Oceans Canada).

	Probability of Achieving Specified Run Sizes [a]				
Stock/Timing	**25%**	**50%**	**75%**	**80%**	**90%**
Early Stuart	**682,000**	**420,000**	**258,000**	**229,000**	**167,000**
Early Summer	**392,000**	**202,000**	**107,000**	**89,500**	**61,000**
Fennell	50,000	26,000	14,000	12,000	8,000
Bowron	39,000	22,000	13,000	11,000	8,000
Raft	42,000	21,000	11,000	9,000	6,000
Gates	62,000	32,000	17,000	14,000	10,000
Nadina	23,000	12,000	6,000	5,000	3,000
Pitt	113,000	62,000	34,000	29,000	20,000
Seymour	16,000	9,000	5,000	4,500	3,000
Scotch	47,000	18,000	7,000	5,000	3,000
Mid Summer	**22,560,000**	**11,715,000**	**6,159,000**	**5,262,000**	**3,490,000**
Chilko	2,465,000	1,578,000	1,010,000	904,000	676,000
Quesnel	14,974,000	7,839,000	4,104,000	3,496,000	2,292,000
Stellako	733,000	424,000	245,000	214,000	150,000
Late Stuart	4,388,000	1,874,000	800,000	648,000	372,000
Late Summer	**1,028,000**	**528,000**	**274,000**	**232,000**	**152,000**
Birkenhead	444,000	247,000	138,000	119,000	81,000
Late Shuswap	11,000	6,000	3,000	2,000	2,000
Cultus	2,000	800	400	300	200
Portage	189,000	86,000	40,000	33,000	20,000
Weaver	382,000	188,000	93,000	78,000	49,000
Total	**24,662,000**	**12,865,000**	**6,798,000**	**5,812,500**	**3,870,000**
Pinks	**7,384,000**	**5,468,000**	**4,049,000**	**3,759,000**	**3,090,000**

a Probability that the actual run size will exceed the specified projection.

Table 2. Preliminary Fraser River sockeye and pink salmon escapement target plan (in thousands of fish) for 2001. (Provided to the Panel by Fisheries and Oceans Canada).

Run	Forecast Return (*a*)	Range of returns	Escapement target	Harvest rate plan	Harvest rate at forecast
Early Stuart		0 - 75	0 - 75	0%	
	258	76 - 380	-	0 to 30%	19%
	420	381 - 760	266	30 to 65%	37%
		>760	-	65-70%	
Early Summer		0 - 105	-	Max 15%	
	107/202	106 - 254	89	15 to 65%	17%-56%
		>254	-	65-70%	
Summer		0 - 4,463	-	0 to 30%	
	6,159	4,464 - 8,926	3,124	30 to 65%	49%
	11,714	>8,926	-	65-70%	65-70%
Late		0 - 217	-	Max 15%	
	273/528	218 - 528	185	15 to 65%	33%-65%
		>528	-	65-70%	
Totals	6,797		3,605		47%
	12,864		4,640		64%
Pink	4049/5468	0 - 7,059	-	Max 15%	
		7,060 - 17,143	6,000	15 to 65%	
		>17,143	-	65-70%	

a At the 75% and 50% probability levels that the actual run size will exceed the specified forecast.

APPENDIX B: EXPLOITATION RATE ON LATE-RUN AND SUMMER-RUN FRASER RIVER SOCKEYE SALMON

Harvest rate directives provided to the Fraser River Panel by the Commission on June 28, 2001:

1. Recognizing that with respect to Fraser River sockeye for 2001 the primary concern of the Commission is the high mortality of late run sockeye, the Commission instructs the Fraser River Panel to develop a fishing plan so that:

- the Parties' fisheries do not exceed a 17% exploitation rate on Late-run sockeye. The United States obligation with respect to the 17% is to manage its fisheries so as not to exceed 17% X 18.4% of the Late-run sockeye;

- and the Parties fisheries do not exceed a 60% harvest rate on Summer-run sockeye.

2. The United States share will not be adjusted post-season as a consequence of Canadian domestic policies that result in Canada not achieving her 81.6%

3. The Commission further directs that

The Fraser River Panel prepare a report in the fall of 2001 to the Commission to recommend procedures for the future designed to ensure appropriate coordination between the bilateral Fraser River Panel and domestic pre-season planning processes.

APPENDIX C: LATE-RUN SOCKEYE STUDIES IN 2001

EXECUTIVE SUMMARIES OF 2001 STUDIES ON POTENTIAL CAUSES OF EARLY UPSTREAM MIGRATION OF LATE-RUN FRSER RIVER SOCKEYE SALMON

In June, 2001, the Pacific Salmon Commission's Standing Committee on Scientific Co-operation approved funding for seven studies on the potential causes of the early upstream migration behaviour observed in Late-run Fraser River sockeye salmon in recent years. Funding for these studies came from the Commission's budget and from the United States Government. Below are the Executive Summaries from the reports prepared by the research scientists, or extracts from the Rapporteur's report of the Third Late-run Sockeye Workshop held at the Pacific Salmon Commission on January 30-31, 2002. The material presented below documents the scope and findings of the studies undertaken to identify the cause(s) of this early migration behaviour.

A. Water Quality/Contaminants

1. Trends in Discharges of Effluent from the Annacis Island STP., R. Addison Ph.D. (Consultant)

Monitoring data from the Annacis Is. Wastewater Treatment Plant (WWTP) between 1991 and 2000 has been examined for possible association with the abnormal late-run sockeye migration first observed in the mid-1990's.

Analysis of monthly mean data showed that total amounts of effluent discharged increased between 1991 and 2000. An appreciable "step" occurred in effluent flow at the beginning of 1995, which may have been due to changes in flow measurement methods. Concentrations of total suspended solids (TSS), biochemical oxygen demand (BOD) and chemical oxygen demand (COD) all increased until 1997 when the implementation of secondary treatment began. Loads of TSS, BOD and COD discharged to the Fraser River also increased until secondary treatment was introduced. Dissolved oxygen (DO) in effluent declined until the introduction of secondary treatment, but ammonia-N concentrations and discharges increased in the late 1990's. Acute toxicity of effluent declined after 1996. In general, effluent quality *improved* following the introduction of secondary treatment. Furthermore, the major changes in effluent quality which occurred between the spring of 1997 and fall of 1998 during the phasing in of secondary treatment, took place *after* the apparent change in sockeye migration. It is therefore difficult to associate any of the major changes in Annacis Is. WWTP effluent discharges with changes in sockeye migration.

Three variables in effluent showed some increase during the early to mid-1990's. These were dissolved iron (which increased sharply in 1995, apparently as a result of groundwater releases during construction at the site) and methylene blue active substances (MBAS) which is generally taken to indicate anionic detergents, and whose increase may indicate a change in detergent use pattern in the service area of the Annacis Island WWTP. Residual chlorine (used in summer months to disinfect effluent) also increased in the early to mid 1990's but excess chlorine should be destroyed by SO_2 treatment before the final discharge of effluent.

Effluent volume, effluent DO and Fraser River discharge volumes were compared on a daily basis for the interval June to September from 1994 to 1999. Effluent DO was lowest in 1996, but total effluent volumes in 1996 were not unusual, nor were Fraser River discharge volumes unusually low. The lowest Fraser River discharge volumes occurred in 1998 by which time effluent DO had increased due to the introduction of secondary treatment. Salmon are sensitive to reduced oxygen tension, but the patterns of effluent volume and DO, and of Fraser River discharges, do not suggest an unusually low oxygen environment which could have triggered unusual behaviour in the mid-1990's. However, no data for DO concentrations in Fraser River "receiving waters" were examined.

Some "candidate" chemicals which are expected to affect salmon migration were considered. Urinary steroid hormones were not measured successfully in Annacis Island WWTP effluents, but calculations based on expected estrogen production by the approximately 1m population served by the plant suggest that estrogen concentrations in effluent could approach those known to have adverse effects on fish. Nonylphenol and its ethoxylates (NP and NPEO) have also been recorded in Annacis Island WWTP effluent, but the physiological significance of the concentrations measured is difficult to assess.

On the basis of the analyses summarized here changes in the operations of, and discharges from, the Annacis Island WWTP over the last decade have not likely had a direct effect on sockeye migration. However, no monitoring data are available for some chemicals which could be "candidates" to cause subtle adverse effects on fish; these include some therapeutic drugs. Furthermore, some chemicals known to cause adverse effects (including urinary steroids and NPEOs) have not been analysed reliably or often enough to allow a reliable assessment of their significance in effluent. Finally, chemical trends in the lower Fraser River "receiving waters" (perhaps arising from changing agricultural or forestry practices) have not been assessed. Future consideration of the role of chemical contaminants in affecting sockeye migration should examine these factors.

2. Impact of Endocrine Disrupting Chemicals on Migration, Reproduction and Survival of Returning Pacific Salmon, M. Ikonomou, Ph.D. (DFO/IOS)

The report discusses the hypothesis investigated in this Study; whether or not contaminants play a role in the abnormal behaviour of salmon or their ability to handle disease challenges. This research focuses on endocrine disrupting chemicals and exposure at different life stages and bio-markers that are linked to contaminants. The research is aimed at determining the contaminant burdens during various life stages and off-loading of contaminants from the mother to eggs that could have toxic effects.

The research is designed to distinguish between two types of effects: (1) the toxicity effect; i.e., controlling mortality; and (2) the endocrine disrupting effect, which controls hormones affecting the ability to reproduce and survive. Having looked at the early life stage, the research team is now beginning to look at exposure during the migration stage. The hypotheses are:

- that the returning adults are bioaccumulating contaminants and are mobilizing these internally into the liver, bloodstream and egg, and that the contaminants are responsible for the mortalities; and
- that there is an uptake of mostly water-soluble contaminants through the gills that are causing the behavioural problem.

3. Contaminant Risk Factors in Sockeye Habitats: Are any chemicals (old or new) disrupting migratory timing? D. Johannessen (DFO/IOS), P. Ross, Ph.D., (DFO/IOS)

A literature search for data on the use of chemicals in British Columbia over a period of time covering the change in behaviour of Late-run Fraser River sockeye salmon was undertaken to determine if contaminants in their environment may be correlated to this change in behaviour.

Contaminants which are likely to be increasing in the BC environment include: endocrine disrupting chemicals – phenols, phthalates, etc. and personal care products, some heavy metals, and a new generation of POPs (persistent organic pollutants) such as polychlorinated napthalenes, polychlorinated paraffins, etc.

The research team proposes a life-history stage-based study of the different types of contaminants to which Late-run sockeye are exposed.

B. <u>Oceanography</u>

1. Biophysical Studies in Support of Research Examining Why Late-run Sockeye Salmon Leave the Strait of Georgia Earlier Than in the Past. R. Beamish, Ph.D. (DFO/PBS), R. Sweeting , Ph.D. (DFO/PBS)

This study focuses on the biophysical aspects of the Strait of Georgia. The team has been unable to find any indicators in the available data that correlate with the 1995-97 fish behaviour change. Regime shifts in the North Pacific Ocean occurred in 1976-77, 1989-90 and again in 1998-99, possibly because of ENSO events (El Nino) or Southern Oscillation index or another proxy – such as the length of day.

The biological productivity in the Strait of Georgia changed in 2000. The biomass of euphasids nearly tripled between 1999 and 2000. This was not only an increase in abundance but also in the size of euphasids. The regime shift of 1998/99 has likely had an impact on the behaviour of Late-run sockeye salmon, but the examination of available data did not indicate the mechanism causing early river entry.

2. Exploratory Data Analysis of Ocean (and Other Parameters Related to Late-run Sockeye Upstream Timing. D. Blackbourn, Ph.D. (Consultant)

This study examined a large number of ocean and other physical parameters for correlation with the early river entry behaviour of Late-run Fraser River sockeye salmon observed in recent years.

The variables that showed large values (+/-) of change in 2000 and 2001 were Gulf of Alaska currents in July and some sea level stations in B.C. and Washington State (although these values were also high in some earlier years).

Future explorations of data were suggested:

- Use estimates of daily discharge and channel cross-section at the Fraser mouth in July, August, September (from UBC Department of Geography) to supplement Hope discharge and Mission estimates of sockeye escapement;
- Check Gulf of Alaska currents and SST during earlier years of the Weaver sockeye marine phase (lagged one or two years), where initial work shows that there are extreme values in the 1990s although none that were unprecedented;
- Incorporate both into some simple models.

3. Late-run Early Migration: A Response to an Abrupt Climate-Scale Shift in Estuarine Exchange Between the Strait of Georgia and Adjoining Coastal Waterways. R. Thomson, Ph.D. (DFO/IOS)

A preliminary analysis of oceanographic conditions in summer and fall along the migration path of Fraser River Late-run sockeye salmon from the open North Pacific to the continental shelf, the Strait of Georgia, Juan de Fuca Strait, and the Fraser River, has revealed the following:

- The pronounced anomalous timing behaviour of the 1998-2001 fish returns are *not* reflected consistently in anomalies of scalar properties – such as sea surface temperature and salinity – in the inner and outer coastal waters of southwestern British Columbia.
- The pronounced anomalous timing behaviour of the 1998-2001 fish returns *are* reflected consistently in the Pacific Decadal Oscillation (PDO) and North Pacific (NPI) indices which indicate a weaker than normal Aleutian Low Pressure system in the Gulf of Alaska, colder than normal SST anomalies along the coast of North America accompanied by warmer than normal SST anomalies in the central North Pacific, and intensified northwesterly wind stress (enhanced upwelling-favourable conditions or, what amounts to the same effect, weaker downwelling-favourable conditions).
- The effect of open ocean SST and surface current patterns during salmon return cannot be ruled out, and the link with salmon migration timing may well be manifested locally with inner coastal waters through links with the large-scale oceanic processes.

A preliminary interpretation of the findings indicates that the observed variability in Late-run sockeye salmon migration timing is linked to variability in the degree of mixing (upper ocean variance structure) in the Strait of Georgia – Juan de Fuca system. Mixing is a function of river runoff, tidal current intensity, and basin-scale winds, with the latter apparently linked to fish

migration timing indirectly through the PDO and NPI. Variability in mixing affects variance in the upper ocean scalar properties – such as temperature and salinity – as well as the mixed layer depth. Ongoing efforts suggest evidence for a link between migration timing and summertime variability of sea surface temperature and salinity in Juan de Fuca Strait, presumably related to the degree of mixing in the strait and the region upstream (i.e., the Strait of Georgia). Although statistically significant correlations between migration timing and the magnitudes of inner and outer coastal winds were not found, continued examination of changes in wind stress variability is intended. Given the encouraging link with the PDO and NPI, a relationship – direct or indirect – between changes in local wind forcing and salmon migration into and out of the Strait of Georgia is expected.

C. Migration/Physiology

1. Weaver Creek Sockeye as a Physiological Model in the Investigation of Pre-spawning Mortality in Early Entry Late-run Fraser River Sockeye Salmon. A. Farrell, Ph.D. (SFU) and E. Donaldson, Ph.D. (Consultant)

Salmon use a variety of environmental cues to successfully migrate into their home rivers. The change in behaviour of Late-run Fraser River sockeye salmon and their early entry into the Fraser River may be related to misreading of cues in relation to the "biological clocks" that control maturation and migration events. For example, the juveniles may be mis-imprinting information on their seaward journey, which later results in the behavioural change as adults. Conversely, adult fish could be entering the Fraser River early because their clocks are triggering migration owing to misreading of environmental cues such as light, salinity, and temperature. Another possible mechanism is extrinsic rather then intrinsic – either an attractant in the river or a repellent in the ocean is driving the fish into the river early.

A separate, yet possibly related issue is the early mortality and failure to spawn. Again, biological clocks would be implicated in three possible ways: a) reproductive hormones follow a distinctive pattern during salmonid maturation, one that is triggered at least six months earlier in the open ocean; therefore, environmental factors in the open ocean cannot be excluded as the precipitating event in these occurrences. Conversely, stress can disrupt and delay reproductive hormone cycles in fish; b) senescence and death follow spawning in Pacific salmon. Therefore, the biological clock for senescence could have become out of phase and advanced relative to the maturation cycle. It is known that surgical removal of the gonads or other means of sterilization in salmon can delay senescence and death; c) osmoregulation processes undergo a major reorganization when salmon move from saltwater to freshwater. Therefore, if fish enter freshwater prematurely, they may be physiologically unprepared for this drastic environmental change, and their body fluids may become osmotically diluted over time. Similarly, they may remain too long in this freshwater environment for their senescence clocks.

This study was a pilot project aimed at providing clues to the possible consequences and causes of early river entry using recognized physiological indicators in sequential samples of Weaver Creek sockeye. Blood and tissue samples were collected from sockeye captured over an eight-week period as the fish were entering the Harrison River and/or delaying there and in Weaver Creek/Channel. The tissues were analyzed for a number of stress, reproductive and metabolic indicators and gill enzyme levels. The working hypotheses were that:

- the fish were abnormally stressed (as revealed by unusually high values for plasma lactate, cortisol and interregnal nuclear diameter);
- the reproductive hormone cycle was abnormal (hormone levels in the blood were not changing as expected); or
- the fish were not properly osmoregulating (as revealed by disturbances to plasma sodium, potassium and chloride levels, plasma osmolality and gill Na^+K^+-ATPase).

The team found the following important patterns:

- Gill Na^+K^+-ATPase (a critical enzyme involved in ionic balance) – levels were generally not as high as those expected for freshwater fish, which suggests that fish may not be able to maintain osmotic status in freshwater over long periods of time;

- Plasma sodium, chloride and osmolality (indicators of osmotic balance) – levels were lower than expected during the later sampling dates which suggest that osmotic problems developed over time;
- Plasma potassium and lactate (good indicators of stress) – levels were higher than expected for rested fish that were sampled early and probably reflect swimming activity prior to capture;
- Plasma cortisol (levels in quiet fish are = 10ng/ml) – levels were more than an order of magnitude higher than expected for resting fish. Even higher values have been observed in Early Stuart sockeye salmon after passage through Hell's Gate; and
- Plasma sex hormones (important in reproductive capability) – peak levels of ketotestosterone in females, testosterone in both males and females, and dihydroprogesterone in males did not reach the expected values, which suggest that the reproductive cycles may have been impaired.

The evidence indicates an osmoregulatory collapse and changes from the expected cycle for certain hormones affecting reproductive timing. The reasons for these findings are unknown. The lack of sufficient data from "normally" migrating Weaver sockeye precludes definitive conclusions.

APPENDIX D: 2001 FRASER RIVER PANEL MANAGEMENT PLAN PRINCIPLES AND CONSTRAINTS

2001 FRASER RIVER PANEL MANAGEMENT PLAN PRINCIPLES AND CONSTRAINTS

1. The 1999 Annex IV, Chapter 4, of the Pacific Salmon Treaty limits the United States harvest (in Washington State) at 18.4% of the total allowable catch (TAC) of Fraser River sockeye salmon and 25.7% of the TAC of Fraser River pink salmon. The United States' shares will be adjusted by up to 57,000 sockeye, due to an overage in catch in 2000, and by 22,000 pink salmon, for an underage in catch in 1999 (not withstanding final resolution of outstanding TAC issues from 2000).

2. Fisheries and Oceans Canada (DFO) provided the Panel with run-size forecasts for Fraser River sockeye by run-timing group and for pink salmon in total. Uncertainty in the forecasts of sockeye and pink salmon for 2001 was accommodated in the planning by using the 50% and 75% probability (p) levels of abundance. At the 75% p level, the returns are expected to reach or exceed 6,797,000 sockeye and 4,049,000 pink salmon. At the 50% p level the returns are expected to reach or exceed 12,864,000 sockeye salmon and 5,468,000 pink salmon.

3. The Panel has adopted a risk-averse management policy for Late-run sockeye and therefore will manage on the presumption that similar to recent years Late-run sockeye will enter the Fraser River early and a significant proportion will not survive to spawn. Late-run and Summer-run sockeye will be managed consistent with the Pacific Salmon Commission agreement of June 27, 2001 (attached).

4. The 2001 Fraser River pink salmon forecast is for a return of 5,468,000 fish. At this run size no directed pink salmon fisheries will take place. Run development will be monitored in-season and if larger runs return and a harvestable surplus is identified, the Panel may conduct fisheries in such a manner as to minimize, to the extent possible, the by-catch of other species and to be consistent with the Commission agreement of June 27, 2001.

5. Management of sockeye salmon run-timing groups and pink salmon will be initiated based on the in-season assessment of likely abundance and run timing.

REGULATIONS

1. If test fishing catches and escapement past Mission indicates that the abundance of Summer-run sockeye salmon in 2001 is approximately at the 50% probability level (11,714,000 fish) and the runs arrive at near-normal dates, fisheries would be expected to commence as follows: United States Areas 4B, 5 and 6C – week of July 22-28; Areas 6, 7 and 7A – week of July 29-August 4. Canadian Area 20 – week of July 29-August 4; Areas 18 and 29 – week of July 29-August 4. Panel decisions will be guided by the fishing pattern in Model run 30B.

2. If the abundance of Summer-run sockeye salmon is indicated to be approximately at the 75% probability level (6,159,000 fish), fishing in marine area fisheries is expected to commence as above. Fisheries in Canadian Area 29 may commence the week of August 12-18. Panel decisions will be guided by the fishing pattern in Model run 31.

3. The Parties' conservation concerns for other species and stocks will be addressed throughout the 2001 management season.

APPENDIX E: 2001 REGULATIONS

The Fraser River Panel approved regulations for the management of the Fraser River sockeye and pink salmon fishery in Panel Area waters and submitted these to the Pacific Salmon Commission. The Commission approved the Fishery Regime and Regulations and submitted these to the respective national governments for approval on June 29, 2001.

Canadian Fraser River Panel Area

In accordance with Article VI, Paragraph 5 of the Pacific Salmon Treaty, the Commission recommends to Canada the adoption of the following Fishing Regime developed by the Fraser River Panel, namely:

1. a) No person shall commercially fish for sockeye or pink salmon in Pacific Fishery Management Area 20-1, 3 and 4 with nets from the 1st day of July, 2001, to the 15th day of September, 2001, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 20-1, 3 and 4 from the 1st day of July, 2001, to the 15th day of September, 2001, both dates inclusive.

2. a) No person shall commercially fish for sockeye or pink salmon in Pacific Fishery Management Areas 17 and 18 with nets from the 1st day of July, 2001, to the 29th day of September, 2001, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 18-1, 4 and 11 from the 1st day of July, 2001, to the 29th day of September, 2001, both dates inclusive.

3. a) No person shall commercially fish for sockeye or pink salmon with nets in Pacific Fishery Management Area 29 from the 1st day of July, 2001, to the 13th day of October, 2001, both dates inclusive.

   b) No person shall troll commercially for sockeye or pink salmon in Pacific Fishery Management Area 29 from the 1st day of July, 2001, to the 13th day of October, 2001, both dates inclusive.

4. The following Fraser River Panel Area waters are excluded:

   a) High Seas westerly of the Bonilla Point-Tatoosh Island Lighthouse Line.

   b) Pacific Fishery Management Area 19, Area 20-2 and 5 to 7 and Area 29-8.

   c) Commercial troll fishing in Pacific Fishery Management Area 17, Area 18-2, 3 and 5 to 10.

During the 2001 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on a 2001 Management Plan adopted by the Panel. This Plan will be designed to achieve Pacific Salmon Treaty-mandated international allocations of the catch and domestic goals of the Parties.

United States Fraser River Panel Area

In accordance with Article VI, Paragraph 5 of the Pacific Salmon Treaty, the Commission recommends to the United States Government the adoption of the following Fishing Regime developed by the Fraser River Panel, namely:

Treaty Indian Fisheries:

1. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 4B, 5 and 6C with drift gillnets or purse seines from the 1st day of July, 2001 to the 15th day of September, 2001, both dates inclusive.

2. No Treaty Indian shall commercially fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 6A, 7 and 7A with nets from the 1st day of July, 2001, to the 22nd day of September, 2001, both dates inclusive.

3. No Treaty Indian shall commercially fish for sockeye or pink salmon with nets in that portion of Puget Sound Salmon Management and Catch Reporting Area 7A lying westerly of a straight line drawn from the low water range marker in Boundary Bay on the International Boundary through the east tip of Point Roberts in the State of Washington to the East Point Light on Saturna Island in the Province of British Columbia from the 23rd day of September, 2001, to the 29th day of September, 2001, both dates inclusive.

All-Citizen Fisheries:

1. No person shall fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 4B, 5, and 6C with nets from the 1st day of July, 2001, to the 15th day of September, 2001, both dates inclusive.

2. No person shall fish for sockeye or pink salmon in Puget Sound Salmon Management and Catch Reporting Areas 6, 6A, 7 and 7A with nets from the 1st day of July, 2001, to the 22nd day of September, 2001, both dates inclusive.

3. No person shall fish for sockeye or pink salmon with nets in that portion of Puget Sound Salmon Management and Catch Reporting Area 7A lying westerly of a straight line drawn from the low water range marker in Boundary Bay on the International Boundary through the east tip of Point Roberts in the State of Washington to the East Point Light on Saturna Island in the Province of British Columbia from the 23rd day of September, 2001, to the 29th day of September, 2001, both dates inclusive.

The following Fraser River Panel Area waters and fisheries are excluded:

Treaty Indian and All-Citizen Fisheries:

1. High Seas westerly of the Bonilla Point-Tatoosh Island Lighthouse Line.

2. Puget Sound Salmon Management and Catch Reporting Areas 6B, 6D, 7B, 7C, 7D and 7E.

During the 2001 season, the Fraser River Panel will adopt Orders establishing open fishing periods based on a 2001 Management Plan adopted by the Panel. This Plan will be designed to achieve Pacific Salmon Treaty-mandated international allocations of the catch and domestic goals of the Parties.

APPENDIX F: 2001 FRASER RIVER PANEL IN-SEASON ORDERS

To provide for adequate escapement of the various stocks of Fraser River sockeye and pink salmon and for the prescribed allocation of catch: (a) internationally, between the United States and Canada and (b) domestically, among the commercial user groups in Canada and the United States, the Fraser River Panel formulated the following orders to regulate Panel Area fisheries in 2001.

July 24 United States:

Treaty Indian Fishery

Areas 4B, 5, and 6C:

Open for drift gill nets from 12:00 p.m. (noon) Wednesday, July 25 to 12:00 p.m. (noon) Saturday, July 28.

July 27 Canada:

Area 29 - 1 to 6 and Area 18 – 1, 4 and 11:

Open for Gear License Area "H" commercial trolling from 12:01 a.m. Saturday, July 28, to 11:59 p.m. Monday, July 30.

United States:

Treaty Indian Fishery

Areas 4B, 5 and 6C:

The previously announced opening for drift gillnets from 12:00 p.m. (noon) Wednesday, July 25, to 12:00 p.m. (noon) Saturday, July 28 remains in effect and is extended from 12:00 p.m. (noon) Saturday, July 28, to 12:00 p.m. (noon) Tuesday, July 31.

July 30 Canada:

Area 29-1 to 6 and Area 18-1, 4 and 11:

Extended for Gear License Area"H" commercial trollers from 11:59 p.m. Monday, July 30, to 11:59 p.m. Tuesday, July 31.

United States:

Treaty Indian Fishery

Areas 4B, 5, and 6C:

The previously announced extension for drift gill nets from 12:00 p.m. (noon) Saturday, July 28, to 12:00 p.m. (noon) Tuesday, July 31 remains in effect and is extended from 12:00 p.m. (noon) Tuesday, July 31, to 6:00 a.m. Wednesday, August 1.

Areas 6, 7 and 7A:

Open for net fishing from 4:00 a.m. Tuesday, July 31, to 6:00 a.m. Wednesday, August 1.

All-Citizen Fishery

Areas 7 and 7A:

Purse seines open from 6:00 a.m. to 9:00 p.m. Wednesday, August 1. Gillnets open from 8:00 a.m. to 11:59 p.m. Wednesday, August 1. Reefnets open from 5:00 a.m. to 9:00 p.m. Thursday, August 2.

August 1 Canada:

Area 20-1,3 and 4:

Open for Gear License Area "B" purse seines with scientific licenses, from 6:00 a.m. to 9:00 p.m., Sunday, August 5, and Monday, August 6. Fisheries and Oceans Canada will adjust the duration and the open areas of this fishery as required on the fishing grounds, based on coho and chinook salmon encounters.

Area 29-1 to 6 and Area 18-1, 4 and 11:

Open for Gear License Area "H" commercial trollers from 12:01 a.m. to 11:59 p.m. Friday, August 3.

August 3 United States:

Treaty Indian Fishery

Areas 4B, 5, and 6C:

Open for drift gillnets from 6:00 p.m. Friday, August 3, to 6:00 p.m. Saturday, August 4.

All-Citizen Fishery

Areas 7 and 7A:

Reefnets open from 5:00 a.m. to 9:00 p.m. Sunday, August 5.

August 6 Canada:

Area 20-1, 3 and 4:

Open for Gear License Area "B" purse seines with scientific license, from 6:00 a.m. to 9:00 p.m., Tuesday, August 7, and Wednesday, August 8. Fisheries and Oceans Canada will adjust the duration and the open areas of this fishery as required on the fishing grounds, based on coho and chinook salmon encounters.

August 17 United States:

All-Citizen Fishery

Areas 7 and 7A:

Reefnets open from 5:00 a.m. to 9:00 p.m. Saturday, August 18, and Monday, August 20.

August 31 United States:

Treaty Indian Fishery

Areas 7 and 7A:

Purse seines open from 5:00 a.m. to 9:00 p.m. Tuesday, September 4 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

All-Citizen Fishery

Areas 7 and 7A:

Purse seines open from 5:00 a.m. to 9:00 p.m. Wednesday, September 5. Reefnets open from 5:00 a.m. to 9:00 p.m. daily from Saturday, September 1, through Wednesday, September 5, in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

September 5 United States:

All-Citizen Fishery

Areas 7 and 7A:

Reefnets open from 5:00 a.m. to 9:00 p.m. daily from Thursday, September 6, through Saturday, September 8 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

September 7 United States:

Treaty Indian Fishery

Areas 7 and 7A:

Purse seines open from 5:00 a.m. to 9:00 p.m. Sunday, September 9 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

All-Citizen Fishery

Areas 7 and 7A:

Purse seines open from 5:00 a.m. to 9:00 p.m. Monday, September 10 and reefnets open 5:00 a.m. to 9:00 p.m., Sunday, September 9 through Tuesday, September 11 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

September 11 United States:

Treaty Indian Fishery

Areas 7 and 7A:

Purse seines open from 5:00 a.m. to 9:00 p.m. Thursday, September 13 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

All-Citizen Fishery

Areas 7 and 7A:

Purse seines open from 5:00 a.m. to 9:00 p.m. Thursday, September 13, and reefnets open 5:00 a.m. to 9:00 p.m., Wednesday, September 12 through Monday, September 17 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

September 13 United States:

Treaty Indian Fishery

Areas 7 and 7A:

Purse seines open from 5:00 a.m. to 9:00 p.m. Friday, September 14 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

All-Citizen Fishery

Areas 7 and 7A:

Purse seines open from 5:00 a.m. to 9:00 p.m. Friday, September 14 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Reefnets open as previously scheduled from 5:00 a.m. to 9:00 p.m. daily from Wednesday, September 12 through Monday, September 17 remains in effect in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point

Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

September 17 United States:

Treaty Indian Fishery

Areas 7 and 7A:

Purse seines open from 5:00 a.m. to 9:00 p.m. Wednesday, September 19 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

All-Citizen Fishery

Areas 7 and 7A:

Reefnets open daily from 5:00 a.m. to 9:00 p.m., Tuesday, September 18 through Saturday, September 22 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

September 18 United States:

All-Citizen Fishery

Areas 7 and 7A:

Purse seines open from 5:00 a.m. to 9:00 p.m., Wednesday, September 19 in the area southerly and easterly of a straight line drawn from Iwersen's dock on Point Roberts in the State of Washington to the Georgina Point Light at the entrance to Active Pass in the Province of British Columbia. Non-retention of sockeye.

APPENDIX G: PANEL AGREEMENT ON 2001 INTERNATIONAL ALLOCATIONS FOR FRASER RIVER PINK SALMON

2001 International Allocations – Pink Salmon

In 2001, unusual circumstances affected the achievement of Fraser pink salmon catch objectives. First, the pre-season forecast of a 5,468,000 Fraser River pink salmon return created an expectation that there would be no directed commercial harvest of Fraser pinks. The final in-season run size estimate was 10 million pinks which would provide for a harvest of 4.0 million fish. This harvest opportunity was unexpected due to the very low pink run prediction and, U.S. processors were unprepared to handle large volumes of fish. Consequently, U.S. Fraser fishermen were faced with low prices and a limited number of buyers to sell pink salmon to. The U.S. took less than 50% of an in-season determined share of approximately 1.0 million pink salmon. Canada chose not to fully harvest its share of Fraser pinks due to an undefined combination of poor market conditions and domestic concerns for potential impacts on late run sockeye and Thompson River coho.

During in-season discussions, the U.S. raised a concern that it did not want Canada's decision not to fully harvest its pink salmon share to affect post-season calculations of TAC in a way that would penalize the U.S. for harvesting its share (or a larger portion of its share than Canada harvested of theirs). Similarities with the 1991 pink returns and fisheries were discussed. A review of the 1991 solution led to an agreement that the 2001 situation should be handled in the same manner (allocations of pink salmon would equal actual catches for 2001 with no penalties resulting from post-season accounting).

APPENDIX H: TABLES 1-14

Table 1. Commercial net catches of Fraser River sockeye salmon in Canadian Area 20 (Juan de Fuca Strait) by week for cycle years 1989-2001.

Date *	1989	1993	1997	2001
Jun. 24-Jun. 30	0	0	0	0
Jul. 1-Jul. 7	0	0	0	0
Jul. 8-Jul. 14	0	0	0	0
Jul. 15-Jul. 21	17,000	0	0	0
Jul. 22-Jul. 28	0	0	0	0
Jul. 29-Aug. 4	266,000	10,000	0	0
Aug. 5-Aug. 11	570,000	136,000	0	48,000
Aug. 12-Aug. 18	1,399,000	314,000	37,000	0
Aug. 19-Aug. 25	826,000	0	105,000	0
Aug. 26-Sep. 1	198,000	0	117,000	0
Sep. 2-Sep. 8	9,000	0	0	0
Sep. 9-Sep. 15	1,000	0	0	0
Sep. 16-Sep. 22	0	0	0	0
Sep. 23-Sep. 29	0	0	0	0
Sep. 30-Oct. 6	0	0	0	0
Total	3,286,000	460,000	259,000	48,000

* Dates for 2001. For other years, data from the nearest week were used.

Table 2. Commercial net and troll catches of Fraser River sockeye salmon in Canadian Areas 17, 18, and 29 (Strait of Georgia and lower Fraser River) by week for cycle years 1989-2001.

Date *	1989	1993	1997	2001
Jun. 24-Jun. 30	0	0	0	0
Jul. 1-Jul. 7	96,000	0	0	0
Jul. 8-Jul. 14	267,000	0	98,000	0
Jul. 15-Jul. 21	50,000	0	0	0
Jul. 22-Jul. 28	0	141,000	60,000	0
Jul. 29-Aug. 4	108,000	50,000	0	51,000
Aug. 5-Aug. 11	130,000	60,000	18,000	6,000
Aug. 12-Aug. 18	436,000	164,000	119,000	0
Aug. 19-Aug. 25	965,000	260,000	282,000	12,000
Aug. 26-Sep. 1	416,000	0	451,000	0
Sep. 2-Sep. 8	12,000	1,970,000	302,000	0
Sep. 9-Sep. 15	2,000	74,000	4,000	0
Sep. 16-Sep. 22	0	30,000	0	0
Sep. 23-Sep. 29	3,000	10,000	0	0
Sep. 30-Oct. 6	0	8,000	0	0
Total	2,485,000	2,767,000	1,334,000	69,000

* Dates for 2001. For other years, data from the nearest week were used.

Table 3. Commercial troll landings of Fraser River sockeye salmon in Canadian Areas 121 to 127 (west coast of Vancouver Island) by week for cycle years 1989-2001.

Date *	1989	1993	1997	2001
Jun. 24-Jun. 30	0	0	0	0
Jul. 1-Jul. 7	11,000	0	0	0
Jul. 8-Jul. 14	15,000	0	0	0
Jul. 15-Jul. 21	2,000	0	0	0
Jul. 22-Jul. 28	42,000	0	0	3,000
Jul. 29-Aug. 4	223,000	0	0	5,000
Aug. 5-Aug. 11	450,000	3,000	0	8,000
Aug. 12-Aug. 18	16,000	352,000	0	0
Aug. 19-Aug. 25	136,000	253,000	0	0
Aug. 26-Sep. 1	143,000	0	0	0
Sep. 2-Sep. 8	9,000	7,000	0	0
Sep. 9-Sep. 15	0	5,000	0	0
Sep. 16-Sep. 22	0	4,000	0	0
Sep. 23-Sep. 29	0	0	0	0
Sep. 30-Oct. 6	0	1,000	0	0
Total	1,047,000	625,000	0	16,000

* Dates for 2001. For other years, data from the nearest week were used.

Table 4. Commercial net and troll catches of Fraser River sockeye salmon in Canadian Areas 11 to 16 (Johnstone Strait and northern Strait of Georgia) by week for cycle years 1989-2001.

Date *	1989	1993	1997	2001
Jun. 24-Jun. 30	0	0	0	0
Jul. 1-Jul. 7	4,000	0	0	0
Jul. 8-Jul. 14	30,000	0	46,000	0
Jul. 15-Jul. 21	40,000	0	0	0
Jul. 22-Jul. 28	161,000	20,000	7,000	47,000
Jul. 29-Aug. 4	776,000	29,000	502,000	87,000
Aug. 5-Aug. 11	973,000	477,000	827,000	30,000
Aug. 12-Aug. 18	2,038,000	3,503,000	2,069,000	0
Aug. 19-Aug. 25	621,000	2,904,000	1,255,000	1,000
Aug. 26-Sep. 1	265,000	252,000	726,000	0
Sep. 2-Sep. 8	61,000	1,285,000	573,000	0
Sep. 9-Sep. 15	15,000	184,000	147,000	0
Sep. 16-Sep. 22	0	21,000	173,000	0
Sep. 23-Sep. 29	0	8,000	83,000	0
Sep. 30-Oct. 6	0	1,000	0	0
Total	4,984,000	8,684,000	6,408,000	165,000

* Dates for 2001. For other years, data from the nearest week were used.

Table 5. Catches of Fraser River mainstem sockeye salmon in the Canadian Fraser River First Nations fishery by area (Fraser River mainstream or tributary areas) for cycle years 1989-2001.*

Fishing Area	1989	1993	1997	2001
Fraser River Mainstem				
Below Port Mann [1]	28,500	139,300	197,100	107,900
Port Mann to Mission [1]	10,400	57,200	193,400	73,600
Mission to Hope	153,200	189,600	104,000	90,500
Hope to Sawmill Cr. [2]	132,500	254,900	299,700	132,000
Sawmill Cr. to Kelly Cr. [2]	146,800	134,200	191,000	185,400
Kelly Creek to Naver Cr. [3]	59,500	42,400	53,200	32,200
Above Naver Cr. [3]	3,200	2,600	6,900	7,700
Total	534,100	820,200	1,045,300	629,300
Tributaries				
Harrison/Lillooet System	3,200	n/a [4]	n/a [4]	n/a [4]
Thompson System	500	100	200	1,100
Chilcotin System	11,300	16,500	15,600	18,700
Nechako System	11,100	3,400	1,900	5,500
Stuart System	11,800	7,800	12,200	9,100
Total	37,900	27,800	29,900	34,400
Total Catch	572,000	848,000	1,075,200	663,700

* Data supplied by DFO.

[1] Prior to 1995, the divisions were Steveston, and Deas to Mission.

[2] Prior to 1993, the divisions were Hope to North Bend, and North Bend to Churn Creek.

[3] Prior to 1994, the divisions were Churn Creek to Hixon, and above Hixon.

[4] No estimate.

Table 6. Commercial net catches of Fraser River sockeye salmon in United States Areas 4B, 5, 6, 6C, 7, and 7A (Juan de Fuca Strait and northern Puget Sound) by week for cycle years 1989-2001.

Date *	1989	1993	1997	2001
Jun. 24-Jun. 30	17,000	0	0	0
Jul. 1-Jul. 7	119,000	0	11,000	0
Jul. 8-Jul. 14	26,000	0	86,000	0
Jul. 15-Jul. 21	49,000	0	11,000	0
Jul. 22-Jul. 28	0	0	18,000	9,000
Jul. 29-Aug. 4	205,000	4,000	36,000	213,000
Aug. 5-Aug. 11	872,000	235,000	91,000	0
Aug. 12-Aug. 18	598,000	672,000	190,000	9,000
Aug. 19-Aug. 25	128,000	909,000	238,000	0
Aug. 26-Sep. 1	183,000	343,000	138,000	0
Sep. 2-Sep. 8	41,000	495,000	274,000	0
Sep. 9-Sep. 15	10,000	34,000	225,000	0
Sep. 16-Sep. 22	0	0	19,000	0
Sep. 23-Sep. 29	0	0	1,000	0
Sep. 30-Oct. 6	0	0	0	0
Total	2,248,000	2,692,000	1,338,000	231,000

* Dates for 2001. For other years, data from the nearest week were used.

Table 7. Commercial net catches of Fraser River pink salmon in Canadian Area 20 (Juan de Fuca Strait) by week for cycle years 1995-2001.

Date *	1995	1997	1999	2001
Jun. 24-Jun. 30	0	0	0	0
Jul. 1-Jul. 7	0	0	0	0
Jul. 8-Jul. 14	0	0	0	0
Jul. 15-Jul. 21	0	0	0	0
Jul. 22-Jul. 28	0	0	0	0
Jul. 29-Aug. 4	0	0	0	0
Aug. 5-Aug. 11	0	0	0	8,000
Aug. 12-Aug. 18	1,000	17,000	0	0
Aug. 19-Aug. 25	97,000	107,000	0	0
Aug. 26-Sep. 1	395,000	177,000	0	0
Sep. 2-Sep. 8	203,000	0	0	0
Sep. 9-Sep. 15	4,000	0	0	0
Sep. 16-Sep. 22	0	0	0	0
Sep. 23-Sep. 29	0	0	0	0
Sep. 30-Oct. 6	0	0	0	0
Total	700,000	301,000	0	8,000

* Dates for 2001. For other years, data from the nearest week were used.

Table 8. Commercial net and troll catches of Fraser River pink salmon in Canadian Areas 17, 18, and 29 (Strait of Georgia and lower Fraser River) by week for cycle years 1995-2001.

Date *	1995	1997	1999	2001
Jun. 24-Jun. 30	0	0	0	0
Jul. 1-Jul. 7	0	0	0	0
Jul. 8-Jul. 14	0	0	0	0
Jul. 15-Jul. 21	0	0	0	0
Jul. 22-Jul. 28	0	0	0	0
Jul. 29-Aug. 4	0	0	0	0
Aug. 5-Aug. 11	0	1,000	0	0
Aug. 12-Aug. 18	3,000	0	0	0
Aug. 19-Aug. 25	19,000	6,000	0	0
Aug. 26-Sep. 1	34,000	48,000	0	0
Sep. 2-Sep. 8	10,000	109,000	0	0
Sep. 9-Sep. 15	3,000	3,000	0	0
Sep. 16-Sep. 22	1,000	2,000	0	0
Sep. 23-Sep. 29	0	0	0	0
Sep. 30-Oct. 6	0	0	0	0
Total	70,000	169,000	0	0

* Dates for 2001. For other years, data from the nearest week were used.

Table 9. Commercial troll landings of Fraser River pink salmon in Canadian Areas 121 to 127 (west coast of Vancouver Island) by week for cycle years 1995-2001.

Date *	1995	1997	1999	2001
Jun. 24-Jun. 30	0	0	0	0
Jul. 1-Jul. 7	4,000	0	0	0
Jul. 8-Jul. 14	15,000	0	0	0
Jul. 15-Jul. 21	27,000	0	0	1,000
Jul. 22-Jul. 28	60,000	0	0	0
Jul. 29-Aug. 4	4,000	0	0	5,000
Aug. 5-Aug. 11	59,000	1,000	1,000	2,000
Aug. 12-Aug. 18	3,000	1,000	0	0
Aug. 19-Aug. 25	149,000	5,000	0	0
Aug. 26-Sep. 1	195,000	2,000	0	0
Sep. 2-Sep. 8	50,000	2,000	0	0
Sep. 9-Sep. 15	4,000	0	0	0
Sep. 16-Sep. 22	3,000	0	0	0
Sep. 23-Sep. 29	0	0	0	0
Sep. 30-Oct. 6	0	0	0	0
Total	573,000	11,000	1,000	8,000

* Dates for 2001. For other years, data from the nearest week were used.

Table 10. Commercial net and troll catches of Fraser River pink salmon in Canadian Areas 11 to 16 (Johnstone Strait and northern Strait of Georgia) by week for cycle years 1995-2001.

Date *	1995	1997	1999	2001
Jun. 24-Jun. 30	0	0	0	0
Jul. 1-Jul. 7	0	0	0	0
Jul. 8-Jul. 14	0	0	0	0
Jul. 15-Jul. 21	0	0	0	0
Jul. 22-Jul. 28	0	0	0	7,000
Jul. 29-Aug. 4	0	37,000	0	10,000
Aug. 5-Aug. 11	58,000	152,000	2,000	31,000
Aug. 12-Aug. 18	0	319,000	0	0
Aug. 19-Aug. 25	277,000	297,000	0	0
Aug. 26-Sep. 1	806,000	533,000	0	150,000
Sep. 2-Sep. 8	208,000	682,000	4,000	530,000
Sep. 9-Sep. 15	187,000	572,000	0	0
Sep. 16-Sep. 22	15,000	342,000	0	0
Sep. 23-Sep. 29	4,000	60,000	0	0
Sep. 30-Oct. 6	0	13,000	0	3,000
Total	1,555,000	3,007,000	6,000	731,000

* Dates for 2001. For other years, data from the nearest week were used.

Table 11. Catches of Fraser River pink salmon in the Canadian Fraser River First Nations fishery by area (Fraser River mainstream or tributary areas) for cycle years 1995-2001.*

Fishing Area	1995	1997	1999	2001
Fraser River Mainstem				
Below Port Mann [1]	28,500	2,200	5,500	500
Port Mann to Mission [1]	32,400	4,200	200	800
Mission to Hope	50,900	14,700	2,700	115,400
Hope to Sawmill Cr. [2]	37,200	6,600	300	400
Sawmill Cr. to Kelly Cr. [2]	5,100	900	0	0
Kelly Creek to Naver Cr. [3]	0	0	0	0
Above Naver Cr. [3]	0	0	0	0
Total	154,100	28,600	8,700	117,100
Tributaries				
Harrison/Lillooet System	0	0	0	0
Thompson System	400	0	0	0
Chilcotin System	0	0	0	0
Nechako System	0	0	0	0
Stuart System	0	0	0	0
Total	400	0	0	0
Total Catch	154,500	28,600	8,700	117,100

* Data supplied by DFO.

[1] Prior to 1995, the divisions were Steveston, and Deas to Mission.

[2] Prior to 1993, the divisions were Hope to North Bend, and North Bend to Churn Creek.

[3] Prior to 1994, the divisions were Churn Creek to Hixon, and Above Hixon.

Table 12. Commercial net catches of Fraser River pink salmon in United States Areas 4B, 5, 6, 6C, 7, and 7A (Juan de Fuca Strait and northern Puget Sound) by week for cycle years 1995-2001.

Date *	1995	1997	1999	2001
Jun. 24-Jun. 30	0	0	0	0
Jul. 1-Jul. 7	0	0	0	0
Jul. 8-Jul. 14	0	0	0	0
Jul. 15-Jul. 21	0	0	0	0
Jul. 22-Jul. 28	2,000	1,000	0	1,000
Jul. 29-Aug. 4	21,000	2,000	1,000	5,000
Aug. 5-Aug. 11	6,000	4,000	2,000	1,000
Aug. 12-Aug. 18	50,000	20,000	0	0
Aug. 19-Aug. 25	536,000	68,000	0	1,000
Aug. 26-Sep. 1	265,000	260,000	0	1,000
Sep. 2-Sep. 8	1,096,000	596,000	0	139,000
Sep. 9-Sep. 15	0	536,000	0	264,000
Sep. 16-Sep. 22	1,000	55,000	0	13,000
Sep. 23-Sep. 29	0	4,000	0	0
Sep. 30-Oct. 6	0	0	0	0
Total	1,977,000	1,546,000	3,000	425,000

* Dates for 2001. For other years, data from the nearest week were used.

Table 13. Escapements of sockeye salmon to Fraser River spawning areas for cycle years 1989-2001.

DISTRICT Stream/Lake	1989	1993	1997	2001	Jacks 2001
NORTHEAST					
Upper Bowron R.	2,534	1,184	4,811	5,842	0
STUART					
Early Runs					
Driftwood R.	250,301	430,226	29,639	15,684	0
Takla L. Streams	54,937	124,892	136,485	77,676	2
Middle R. Streams	47,876	71,551	64,465	39,212	0
Trembleur L. Streams	31,685	61,296	35,108	38,087	0
Early Stuart Total	384,799	687,965	265,697	170,659	2
Late Runs					
Kazchek Cr.	767	8,568	6,746	5,607	0
Kuzkwa Cr.	4,122	51,779	107,560	15,926	0
Middle R.	276,131	388,937	281,472	131,505	0
Tachie R.	287,290	1,339,755	491,098	187,591	312
Miscellaneous	7,387	15,930	20,776	10,886	0
Late Stuart Total	575,697	1,804,969	907,652	351,515	312
NECHAKO					
Nadina R. (Late)	545	1,000	4,588	19,891	6
Nadina Channel	4,395	8,595	4,911	34,849	3
Stellako R.	43,179	91,071	55,343	151,359	73
QUESNEL					
Upper Horsefly R.	658,452	1,649,829	929,821	1,816,654	39
Lower Horsefly R.	814,818	- [1]	- [1]	- [1]	
Horsefly Channel	23,300	17,891	0		0
McKinley Cr.	117,830	169,368	262,082	267,413	14
Mitchell R.	240,521	725,030	534,431	920,267	0
Miscellaneous	15,899	58,336	132,318	506,455	3
Quesnel Total	1,870,820	2,620,454	1,858,652	3,510,789	56
CHILCOTIN					
Chilko R.	51,580	549,845	978,328	668,783 [2]	1,084
Chilko Channel	1,459	5,381	7,499		0
Chilko L.-South End	10,229	- [3]	- [3]		
SETON-ANDERSON					
Gates Cr.	2,968	1,188	777	459	14
Gates Channel	13,995	16,764	5,721	12,462	394
Portage Cr.	7,900	19,760	9,766	3,150	9
NORTH THOMPSON					
Raft R.	1,647	5,047	6,093	32,498	8
Fennell Cr.	3,988	7,546	9,000	5,721	25
SOUTH THOMPSON					
Early Summer Runs					
Seymour R.	5,507	10,114	2,254	6,892	182
Scotch Cr.	7,236	8,359	3,085	2,449	148
Late Runs					
Lower Adams R.	73	540	979	3,142	13,654
Lower Shuswap R.	488	745	138	194	877
HARRISON-LILLOOET					
Birkenhead R.	29,334	244,954	50,202	44,450	277
Harrison R.	2,934	3,258	1,418	15,309	0
Weaver Cr.	4,864	34,555	4,275	4,205	74
Weaver Channel	12,303	49,901	21,229	15,710	102
LOWER FRASER					
Chilliwack L.	89	500	773	30,272	239
Nahatlatch R./L.	3,628	2,078	9,959	5,441	0
Cultus L.	418	1,063	88	515	160
Upper Pitt R.	16,037	22,835	35,798	131,481	19
MISCELLANEOUS	1,474	201,830	2,885	28,665	3,950
ADULTS	3,060,120	6,401,501	4,251,921	5,256,702	
JACKS	47,337	25,724	9,038	21,668	21,668
TOTAL NET ESCAPEMENT	3,107,457	6,427,225	4,260,959	5,278,370	

* Estimates for 1989, 1993, 1997, and 2001 are from DFO.

1 Included in Upper Horsefly estimate.

2 Includes Chilko Lake and channel

3 Included in Chilko River estimate.

Table 14. Fraser River pink salmon production for odd brood years from 1961-1999.

Brood Year	Spawners		Potential Egg Deposition	Fry Production	Adult Returns (Catch + Escapement)	% Survival		Average To Date
	Total (millions)	Female (millions)	(millions)	(millions)	(millions)	Freshwater	Marine	
1961	1.094	0.654	1,569	143.6	5.477	9.2%	3.8%	3.8%
1963	1.953	1.216	2,435	284.2	2.320	11.7%	0.8%	2.3%
1965	1.191	0.692	1,488	274.0	12.968	18.4%	4.7%	3.1%
1967	1.831	0.973	2,132	237.6	3.928	11.1%	1.7%	2.8%
1969	1.529	0.957	2,018	195.6	9.767	9.7%	5.0%	3.2%
1971	1.804	1.096	1,923	245.4	6.789	12.8%	2.8%	3.1%
1973	1.754	1.009	1,865	292.4	4.894	15.7%	1.7%	2.9%
1975	1.367	0.781	1,493	279.2	8.209	18.7%	2.9%	2.9%
1977	2.388	1.362	2,960	473.3	14.404	16.0%	3.0%	2.9%
1979	3.561	2.076	3,787	341.5	18.685	9.0%	5.5%	3.2%
1981	4.488	2.560	4,814	590.2	15.346	12.3%	2.6%	3.1%
1983	4.632	2.931	4,702	554.8	19.104	11.8%	3.4%	3.2%
1985	6.461	3.561	5,900	256.1	7.172	4.3%	2.8%	3.1%
1987	3.224	1.856	3,471	406.9	16.484	11.7%	4.1%	3.2%
1989	7.189	4.383	7,198	360.0	22.173	5.0%	6.2%	3.4%
1991	12.943	8.002	12,330	697.0	16.983	5.7%	2.4%	3.3%
1993	10.768	6.454	9,192	439.0	12.904	4.8%	2.9%	3.3%
1995	7.175	4.248	10,233	272.3	8.176	2.7%	3.0%	3.3%
1997	2.842	1.740	2,863	252.8	3.616	8.8%	1.4%	3.2%
1999	3.422	1.885	2,702	222.8	21.293	8.2%	9.6%	3.5%
Average	4.081	2.422	4,254	340.9	11.535	10.4%	3.5%	

APPENDIX I: STAFF OF THE PACIFIC SALMON COMMISSION IN 2001

EXECUTIVE OFFICE

Mr. D. Kowal, Executive Secretary
Ms. S. Schnurr, Secretary (Term)
Mrs. V. Ryall, Meeting Planner
Ms. T. Tarita, Librarian/Records Administrator

FINANCE AND ADMINISTRATION

Mr. K. Medlock, Controller
Ms. B. Dalziel, Accountant

FISHERIES MANAGEMENT DIVISION STAFF

Dr. J. Woodey, Chief

BIOMETRICS / CATCH STATISTICS GROUP

Mr. I. Guthrie, Head

COMPUTER SERVICES GROUP

Ms. K. Mulholland, Computer System Manager
Ms. S. Wadley, Information Technology Support Specialist

RACIAL IDENTIFICATION GROUP

Mr. J. Gable, Head
Ms. H. Anozie, Scale Lab Assistant
Mr. K. Forrest, Racial Data Biologist
Mr. M. Lapointe, Sockeye Racial Analysis Biologist
Ms. M. Reichardt, Senior Scale Analyst
Ms. J. Sellers, Scale Analyst
Mr. B. White, Pink Racial Analysis Biologist

STOCK MONITORING GROUP

Mr. J. Cave, Head
Mr. P. Cheng, Hydroacoustics Biologist
Mr. A. Gray, Hydroacoustics Biologist
Ms. F. Martens, Hydroacoustics Technician (Term)
Ms. C. Tovey, Test Fishing Biologist
Dr. Y. Xie, Hydroacoustic Scientist